

A review of the genus *Fulvia* Gray, 1853 (Mollusca, Cardiidae).

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ABSTRACT. The Cardiid genus *Fulvia* is revised based on examination of type material and over 900 lots in relevant museums. Characters of shell sculpture are regarded as taxonomically more reliable than shape and colour, hitherto the base of specific taxonomy in the genus. It is established that *Fulvia* shares with *Vepricardium* numerous characters, including the presence of ocular organs on siphonal tentacles, and is included here in the tribe VEPRICARDIINI. *Laevifulvia* subgen. nov. [Type species: *F. undatopicta* Pilsbry, 1904] is segregated from *Fulvia* s.s., based on the lack of periostracal insertions on the ribs. Sixteen Indo-Pacific species of recent *Fulvia* are recognized, of which six are new. The name *F. papyracea*, hitherto used for a common Indo-West Pacific species is shown to represent a rare and restricted species. The name *F. fragilis* (Forsskal in Niebuhr, 1775) is to be used for most usages of *F. papyracea* of authors.

RESUME. Révision du genre *Fulvia*, famille CARDIIDAE, basée sur l'examen du matériel type et de plus de 900 lots de différents muséums. Les caractères de l'ornementation de la coquille sont considérés comme taxonomiquement plus fiables que la forme générale ou la couleur, sur lesquelles, jusqu'à présent, les séparations spécifiques sont basées. Il est constaté que les *Fulvia* partagent avec les *Vepricardium* de nombreux caractères, en particulier la présence d'organes oculaires à l'extrémité des tentacules siphonaux, et sont donc placées ici dans la tribu des VEPRICARDIINI. On sépare de *Fulvia* s.s. un sous genre *Laevifulvia* [Espèce type *F. undatopicta* Pilsbry, 1904], séparation basée chez ce dernier sur l'absence d'insertions périostacales sur les côtes. Il est reconnu seize espèces récentes de *Fulvia* dans l'Indo-Pacifique, dont six sont nouvelles. On montre que le nom *Fulvia papyracea*, utilisé jusqu'ici pour désigner une espèce commune de l'Ouest de l'Indo-Pacifique, représente en réalité une espèce rare et d'extension limitée. Le nom *F. fragilis* (Forsskal in Niebuhr, 1775) doit être utilisé, la plupart du temps, à la place de *F. papyracea* utilisé par les auteurs.

INTRODUCTION

This general study originates from an attempt to identify some species of the genus *Fulvia* found around New Caledonia. For these identifications I both consulted literature and compared identified specimens in museums. The result was very confusing and I remained perplexed about the true identity of many forms at the specific level, the generic level always being easy to determine. The literature on this subject is of little help because the descriptions are always too succinct, the effective comparisons quasi-absent, and opinions often vary from an author to another. In the museums the identifications are also often rather disconcerting. I then presumed that the reason of this confusion could be the inconsistency of the characters in the species of this genus. As a matter of fact, they are generally reputed to be

very polymorphic and, although there are twenty five nominal species, the most recent authors have been prudently inclined to consider only a small number of species (about four or five) in this group, and FISCHER-PIETTE (1977) admits the existence of only two species of recent *Fulvia*!

MATERIAL AND METHODS

In the literature, the criteria for description and species separation are scarce and rather vague and subjective. They mainly concern the general shape of the shells, the colours and the strength of the ribs, characters which, at first sight, look variable in a same species and may be common to several. The review of the genus *Fulvia* consisted of examining systematically in each specimen the largest number of characters, beside shape and colours, in order to find

characters with significant taxonomic importance.

The type specimens are very rarely cited and can often be supposed as not having been taken into account by the authors. Almost all the extant types specimens have been examined.

For this study about 905 lots have been examined and, in almost half this number, at least one, often several specimens, have been measured. In this material, about 588 lots originate from ORSTOM's dredging program conducted by B. Richer de Forges in the peripheral lagoon of New Caledonia and in the shallows of Chesterfield Islands, from 1984 to 1992. This material is in the MNHN.

This material comes from the following museums:

- AMS: Australian Museum - Sydney.
- ANSP: Academy of Natural Sciences - Philadelphia.
- BM(NH): British Museum (Natural History) - London.
- IRSNB: Institut Royal des Sciences Naturelles de Belgique - Brussels.
- MHNG: Museum d'Histoire Naturelle de Genève - Geneva.
- MNHN: Museum National d'Histoire Naturelle - Paris.
- NM: Natal Museum - Pietermaritzburg.
- QM: Queensland Museum - Brisbane.
- WAM: Western Australian Museum - Perth.
- ZMA: Zoologisch Museum - Amsterdam.
- ZMUC: Zoologisk Museum - Copenhagen.

DEFINITIONS

In order to simplify the descriptions, some expressions are used, defined as follows:

A = Angle A: In the right valve, the angle between two lines joining the main cardinal tooth to the laterals.

AT= Anterior Third of the shell in a radial division, excluding the lunule *sensu stricto* and the sublunule (pl. 1, fig. 1).

When the sublunule is long this "third" is reduced.

D = Ratio D: In the left valve, the ratio between two distances: the distance from the extremity of the posterior lateral to the tip of the umbo and the distance from this point to the middle of the anterior lateral.

Granulation, granules (pl. 1, figs. 4 and 8; pl. 2, fig. 10; pl. 3, fig. 7): Minute tubercles very often present on the external surface of the shell. They can be concentrically aligned, sometimes on long distances (several ribs and interstices). They are usually situated on the anterior half of the shell but can be present everywhere. These small tubercles have an hexagonal symmetry in most species.

IMR = Internal Marginal Ribbing: The reverse of the external ribbing extending onto the internal side of the shell at the margin and in a certain distance from it. This "ribbing" is always well discernible and the comparison of the width between ribs and interstices (which is an important taxonomic character) is always easier to observe in the IMR.

Interstitial riblets: In the posterior third of the shell, more or less numerous small ribs, often irregular, can appear in the interstices between the main ribs (pl. 1, fig. 8).

Last flat: On the external posterior part of the left valve, the area, often relatively wide, between the last rib and the dorsal margin, bearing the posterior lateral on its inner side. This zone is generally flat or slightly concave (pl. 1, fig. 8).

Last fold: On the external posterior part of the right valve, the area, often relatively wide, between the last rib and the dorsal margin, bearing the posterior lateral on its inner side. This zone is generally convex. When the shell is closed, the last fold partially overlaps the last flat (pl. 1, fig. 8).

Lunule: It is not a true lunule (present only in FRAGINAE) but the most anterior part of the shell, always without ribs and periostracal insertions, often separated from the rest of the shell by the perilunular furrow (see this word). The smooth zone can extend farther backwards (sublunule), but, in the descriptions, the lunule *sensu stricto* will be limited at the level of the extremity of the basement of the anterior teeth, even when a furrow is not present, and its "length" along the margin will be measured from this point to the extremity of the umbo (pl. 1, fig. 1).

Lunular heart: The anterior dorsal margin of the shell just beside the umbo, exteriorly arising and spreading on both sides, forming like a "heart" (pl. 1, figs. 2 and 3).

Ocular organs: Situated on the tip of tentacles bordering the two siphonal apertures; they are generally darker.

MT = Medial Third in a radial division (pl. 1, fig. 1).

Perilunular furrow: The lunule *sensu stricto* is sometimes limited by a more or less large and deep furrow, a slight and open groove corresponding internally to the ridge supporting the anterior tooth.

Periostracal insertions: In most species, periostracal lamellae are perpendicularly implanted in the shell on or along the ribs. These insertions consist of a succession of elementary components formed with short concentric lamellae and longer radial ones, forming "nodes" at their intersection, with a simple (pl. 1, fig. 5) or complex arrangement (pl. 1, fig. 7) according to the different species. Joined end to end these basic elements form finely undulating or zigzagging palisades on or along the ribs. These fragile palisades often disappear when the shell dries, but the traces of the insertions are always visible on the surface of the shell. Sometimes the nodes become calcified and form tubercles or spines on the ribs (pl. 1, fig. 6).

Posterior groove: Most species have a distinct more or less pronounced radial groove in the middle of the posterior third of the shell forming a notch in the margin and corresponding interiorly to a raised radial oblique ridge.

PT = Posterior Third of the shell in a radial division, often divided into two parts by the axis of the posterior groove (see above): PT1: the anterior part, close to the MT and PT2: the posterior part, ending beside the last flat or the last fold. Often, these two parts of the PT have distinct ribs (pl. 1, fig. 1).

Sublunule: In some species the lunule *sensu stricto* is followed by a more or less developed area without ribs nor IMR, but with some possible periostracal insertions. This area is sometimes separated from the lunule by a "perilunular furrow" (see this word). The length of the sublunule along the margin will be estimated by comparison with the length of the lunule (pl. 1, fig. 1).

TAXONOMY OF THE GENUS *FULVIA* GRAY, 1853

The taxon *Fulvia* was created as a monotypic genus of the family "CARDIADAE" by GRAY (1853: 40), with a type species: *Fulvia aperta* Bruguière, from the Indo-Pacific. Also Gray cites another genus: *Papyridea* Swainson, 1840, for which he had designated the type species (1847: 185): *Papyridea soleniforme*, from the American Atlantic. In spite of these

clear, logical and unambiguous definitions, and in spite of the fact that these two species, the gaping excepted, are extremely different, the majority of the subsequent authors did not follow Gray and, for a long time, *Fulvia* was erroneously considered as a subgenus of *Papyridea*. In 1951, KEEN justly separated both taxa: *Papyridea* was placed, as a genus, into the subfamily TRACHYCARDIINAE and *Fulvia*, as a subgenus of *Laevicardium*, into the subfamily LAEVICARDIINAE Keen, 1951. [The erection of LAEVICARDIINAE by KEEN (1936: 367) does not comply with ICZN art.13,(a),(i), and is nomenclaturally unavailable]. KAFANOV & POPOV (1977: 310) consider *Fulvia* and *Laevicardium* as two genera of the tribe LAEVICARDIINI, subfamily CARDIINAE. Finally, SCHNEIDER (1992: 146), again places *Fulvia* and *Laevicardium* into the subfamily LAEVICARDIINAE.

Nevertheless, several authors, for example WILSON & STEVENSON (1977: 52), have noted that "the species of *Fulvia* do not agree with the diagnosis of *Laevicardium*" for many reasons. This study confirms the veracity of this opinion and it can be remarked also that the species of *Fulvia* have numerous affinities with the species of *Vepricardium* Iredale, 1929. These similarities are as follows:

1)- Shape comparable, with length more or less equivalent to height, often equilateral with rounded margins and no or limited posterior truncation.

2)- Hinge similar with, in particular, a large angle A.

3)- Several other features are comparable in both groups: large lunule with a lunular heart, well developed last fold overlapping a last flat etc...

4)- Young specimens of *Vepricardium* are also radially divided into three parts, with a smoother median one, and can look very much like *Fulvia*.

5)- Young specimens of some *Vepricardium* bear also "periostracal insertions", which turn into calcified palisades or spines in the adults, with equivalent detailed structures.

6)- In some species of *Fulvia*, the nodes of the periostracal insertions change into calcified spines, like those of *Vepricardium*.

7)- The external surface of the shell, in both groups, bears numerous minute granules, often concentrically aligned.

8)-The last but maybe the most significant element of similarity: the presence in both groups of ocular organs (see above). As far as I know, this character does not exist in the other

CARDIIDAE, except in the two species of the European genus *Cerastoderma*.

Because of these numerous affinities, I think that *Fulvia* and *Vepricardium* must be placed into a same suprageneric group and logically into the tribe VEPRICARDIINI, subfamily CARDIINAE (see later).

As far as *Laevicardium* s.s. is concerned, the species of this genus remain similar to *Acrosterigma* Dall, 1900, as far as certain characters are concerned, and should be placed into the tribe TRACHYCARDIINI Stewart, 1930. Nevertheless, it is true that some characters of *Laevicardium* are present in some evolved species of *Fulvia* (particularly in the subgenus *Laevifulvia*). I think this is due to a phenomenon of convergence.

In brief the taxonomy of *Fulvia* is considered here as follows.

Family CARDIIDAE Lamarck, 1809,
Subfamily CARDIINAE Lamarck, 1809,
Tribe VEPRICARDIINI
Kafanov & Starobogatov
(in Kafanov & Popov, 1977).

Genus *Fulvia* Gray, 1853.

Type species: *Fulvia aperta* (Bruguère).

General characters: Shell often thin and fragile, more or less translucent, but sometimes moderately thick and opaque. Dimensions variable from small (10 mm) to large (100 mm) in length.

Shape: Rarely noticeably elongated (length generally nearly equivalent to height), varying from subcircular and equilateral to inequilateral, with the posterior side more or less transversally to obliquely expanded. Sometimes slightly truncated on the posterior margin, the anterior and ventral margins being always rounded. Variably but rather moderately inflated, with a regular general concentric curvature of the shell (no or exceptional medio-posterior accentuation of the curvature nor rostration). Often, presence of a "posterior groove" (see above). The shells are generally practically closed in the posterior margin, only two species noticeably gaping.

Other external features: (See above for certain definitions). Umbo generally prosogyrate without exaggeration. "Lunule" generally broad, with a variably developed "lunular heart". "Sublunule" from nonexistent to extremely well developed. Presence of a "last flat" and a "last fold", both of variable extension and profile.

Colours: Exterior of the shells of variable colour: white, beige or yellowish to orange, brown purple, with often, mainly in the young shells, more or less developed darker irregular concentric stripes or zigzags dark yellow, brown to pink or purple. The tip of the umbo is often coloured purple, and also sometimes the sublunule and part of the posterior third.

Interior generally white, beige to orange often with more or less developed irregular concentric stripes corresponding to those in the exterior and also one or two thin radial lines crossing the above stripes. Posterior zone often coloured purple. Sometimes the interior is almost entirely coloured pink, orange, brown or purple, and sometimes only in the umbonal cavity.

Sculpture:

a)- Number of ribs: This number is extremely variable between the species, and within some species according to populations and individuals. It ranges between 33 and 68.

b)- Ornamentation:

The young shells (and the earliest formed part of the adult shells) are smooth, except for some large ribs in the PT1. When the shell grows, ribs and interstices appear progressively in the other parts. They are always the strongest and the largest in the PT and the weakest in the MT, where they can sometimes be hardly perceptible. Nevertheless the internal marginal features (IMR, which have a significant taxonomic interest) are obvious everywhere. In the PT some irregular interstitial riblets can appear in the interstices. In some species the ribbing and the IMR disappear in the most anterior part of the shell, behind the lunule (sublunule more or less developed).

The profile of the ribs and interstices varies according to the species and to the position on the shell. The ribs are often flat, with rounded edges, but can be triangular or rounded. They are generally smooth, without any ornaments, but in some rare species tubercles can appear. The interstices are generally flat and of very variable width with regard to the ribs. They are generally smooth but they can be striated in the PT.

In most species the ribs bear "periostacal insertions". They are generally located on the posterior limit of the ribs, but they can be placed in a variable position from this limit to the middle of the rib. When they exist, these insertions are present on all the ribs of the shell. They sometimes remain also in the sublunule, although the ribs and IMR have disappeared.

In some species, one, sometimes two, periostracal insertions develop on the last flat or the last fold.

The external surface of the shell is almost always ornamented with minute tubercular granules, often not perceptible with the naked eyes. These microscopic pustules mostly develop in the anterior part of the shell, but they can be present everywhere. They are often concentrically aligned. They can be limited to the interstices, or to the ribs, or to be placed on both.

Hinge: Hinge plate narrow, thin, moderately curved (angle A varying from 150° to 120°), occasionally angled in its anterior part, rarely excessively asymmetric (ratio D generally varying from 1.0 to 1.2, but sometimes reaching more extreme values: 0.8 to 2.0).

Cardinals generally unequal and separated in the left valve, approximately equal and touching at their base in the right valve.

Posterior lateral in the left valve very low, elongated, blade-like, often hardly separated from the ventral margin; in the right valve this tooth is higher and triangular. The main anterior lateral in the right valve is thin, pointed and triangular; it is prolonged towards the umbonal area below the hinge plate, forming a very regularly arced well delineated ridge, flattened against the internal surface of the shell. In the left valve the anterior lateral is roughly triangular and is prolonged by a raised narrow ridge, more or less elevated, separated from the dorsal margin by a deep elongated cleft which reaches the cardinal area. The ventral border of the above internal ridges limiting the anterior laterals corresponds exactly with the limits of the lunule.

Soft parts: The softs parts of ten species (of sixteen) have been observed, plus one literature record. All have two siphonal apertures bordered by tentacles, and some of these tentacles always bear dark ocular organs on their tip.

The genus *Fulvia* will here be separated into two subgenera:

Subgenus *Fulvia*

Type species: *Fulvia aperta* (Bruguière).

Diagnosis: See general diagnosis of the genus *Fulvia*, periostracal insertions present.

Subgenus *Laevifulvia* new subgen.

Type species: *Fulvia undatopicta* (Pilsbry).

Diagnosis: See general diagnosis of the genus *Fulvia*, but no periostracal insertions.

SPECIES LIST AND IDENTIFICATION KEY

A)- *Fulvia* (*Fulvia*): Periostracal insertions.

- 1a: Presence of a rather long sublunule 2
1b: Very short or no sublunule 3

2a: Sublunule as long as the lunule:

Fulvia (*F.*) *dulcis* (Deshayes, 1863): Small, equilateral, large lunular heart, irregularly coloured, ribs in AT and MT hardly perceptible, ribs strong in PT.

2b: Sublunule shorter than the lunule:

Fulvia (*F.*) *scalata* sp. nov.: Small, equilateral, very large lunular heart, uniformly coloured, ribs strong in PT and AT, perceptible in MT. Granules in AT and PT aligned like rungs of ladder in the interstices. Triangular nymph.

- 3a: In MT, ribs and interstices of unequal width 4

- 3b: In MT, ribs and interst. of about the same width 6

- 4a: In MT and part of AT, ribs very much wider than interstices:

Fulvia (*F.*) *mutica* (Reeve, 1844): Large to v. large, uniformly coloured, ribs in MT very weak but IMR well marked. Periostr. insertions strong, always placed in the middle of the ribs. No granulation in adult specimens.

- 4b: In MT and part of AT, ribs very much narrower than interstices 5

5a: Shell equilateral, not gaping:

Fulvia (*F.*) *papyracea* (Bruguière, 1789): Large, ribbing very weak in MT, numerous granules in AT, hinge regularly curved, ratio D about 1.2.

5b: Shell inequilateral, gaping:

Fulvia (*F.*) *aperta* (Bruguière, 1789): Large, lunule large, ribbing very weak in MT, granulation in AT, hinge anteriorly angled, ratio D about 1.0 or less.

- 6a: Ribs and interstices not flat (rounded or triangular) 7

- 6b: Ribs and interstices flat 9

- 7a: Shell fragile, gaping, dark colour, discretely ribbed:

Fulvia (*F.*) *natalensis* (Krauss, 1848): Medium to large, inequilateral, lunule very small, ribbing regular on the whole shell, no granulation, hinge not angled, ratio D very high (1.4 to 1.9).

- 7b: Shell solid, closed, light colour, markedly ribbed 8

8a: Ribs flatly rounded to asymmetrically triangular in MT, rather rounded in AT:

Fulvia (*F.*) *fragilis* (Forsskal, 1775): Medium to large, last fold high and regularly rounded, 41 ribs (34-52), calcareous spines in PT2, granules only in young shells very anteriorly.

8b: Ribs symmetrically triangular in MT, rather triangular in AT:

Fulvia (*F.*) *tenuicostata* (Lamarck, 1819): Medium to large, last fold very large with two parts (round and flat), 51 ribs (44-59), No calcareous spines in PT2. Granules rather rare in AT.

9a: Elongated calcified tubercles in PT:

Fulvia (*F.*) *boholensis* sp. nov.: Medium, inequilateral, generally orange, IMR in MT often almost indistinct.

9b: No calcified tubercles in PT 10

10a: Shell small, roundly angled between MT and PT:

Fulvia (*F.*) *fragiformis* sp. nov.

10b: Shell medium, with regular concentric curvature:

Fulvia (*F.*) *australis* (Sowerby, 1834): More often than not obliquely inequilateral, in MT and AT: identical weak flat regular ribbing, strongly contrasting with the one in PT, much wider and stronger and rather irregular.

B)- *Fulvia* (*Laevifulvia*): No periostracal insertions:

1a: Shell elongated when adult, higher than long 2

1b: Shell not elongated. 3

2a: Sublunule about as long as lunule:

Fulvia (*L.*) *undatopicta* (Pilsbry, 1904): Small, equilateral, often 4 "crushed" spots, numerous aligned granules in AT.

2b: Sublunule much longer than lunule:

Fulvia (*L.*) *lineonotata* sp. nov.: Small, inequilateral, coloured by small aligned triangles, thin granules in AT.

3a: Shell longer than high:

Fulvia (*L.*) *hungerfordi* (Sow, 1901): Small, asymmetric, "polygonal" aspect, granules on the whole shell, ribbing and IMR in MT variable.

3b: Shell as long as high. 4

4a: Shell small, very inequilateral:

Fulvia (*L.*) *prashadi* sp. nov.: Ridged and strongly separated sharpened PT, No ribbing nor IMR in MT, strong in PT, very rare or no granules.

4b: Shell medium, almost equilateral:

Fulvia (*L.*) *ballieni* sp. nov.: Regular weak ribbing and IMR in MT and AT, larger ribbing in PT. Granules on the umbo.

SPECIES DESCRIPTIONS.

Fulvia (*Fulvia*) *aperta* (Bruguère, 1789)
(pl. 1, figs. 9a-b; pl. 2, fig. 7).

Cardium apertum sive hians, testa tenui etc...
Chemnitz, 1782 :189, pl.18, figs. 181-183 (Not binominal).

Cardium apertum Chemnitz: Bruguère, 1789: 226.

Synonyms:

Cardium "rogata" (sic) Gronovius, 1781: 266 and Index No 1125, pl. 18, fig. 5 (Not binominal).

Cardium hians Spengler, 1799: 39.

Cardium rugatum "Gronovius": Dillwyn, 1817: 125.

Questionable synonyms:

Cardium virgineum Linn., 1758: 682. (See Dodge 1952: 67).

Cardium bullatum Linn., 1758:673. (See Dodge 1952: 37, 68).

Types:

C. apertum: Bruguère's 1789 description is based only on Gronovius and Chemnitz, and the only shells cited are the ones figured by these authors. Gronovius' specimen has not been traced, but Chemnitz's specimen is still in the ZMUC, Spengler collection, Ref. BIV 42. It is erroneously located from Jamaica. Dimensions: H=48.6, L=48.1, W=30.5. D=1.0. With 44 ribs. This shell is here selected as **lectotype** of *Cardium apertum* (pl. 1, figs. 9a-b).

C. rugatum: The specimen figured by Gronovius was not located.

C. hians: Spengler had two **syntypes** in his own collection of this nominal species, now in the ZMUC: the specimen BIV 42 above cited, and another specimen BIV 43. Dimensions of the latter: H=43.6, L=44.4, W=29.3. D=0.92. With 44 ribs. The specimen BIV 42 is here selected also as **lectotype** of *Cardium hians*, so this taxon becomes an objective synonym of *C. apertum*.

C. virgineum and *C. bullatum*: no type specimens located.

Description:

Shell of medium size, up to 48 mm in length.

Shape relatively constant, inequilateral, with its anterior side short and rounded and its posterior side transversally expanded, often

slightly truncated and always raised at its extremity, causing a significant gaping (pl. 2, fig. 7). Sometimes, the flattening of the lunular area sharpens the anterior side a little. No or very weak posterior groove. Length always a little greater than eight.

Lunule very large, with a significant perilunular furrow. No lunular heart. No sublunule. Last flat present, but small, in the young shells only; when the shells become adult it decreases progressively in width, then disappears. Last fold rounded, high but narrow, without periostracal insertions.

External colour variable, uniformly whitish or beige or with irregular concentric zones of purple red to brown, sometimes only spotted with these colours. The density of the coloured zones generally decreases with the growth of the shell. Umbo often purple.

Internal colours generally the same by transparency except in the posterior area, almost always purple coloured. Sometimes, presence of a thin radial red strip in the umbonal cavity.

Mean number of ribs 43 (range 39-48).

In the whole AT and MT zones, the ribs are triangular, very narrow, and the interstices flat and comparatively very large. In the PT1 the ribs become flatly triangular, increasing in width, and in the PT2 they become equivalent to the interstices. The LMR extends far from the margin.

The periostracal insertions are always situated in the posterior side of the ribs, and form complex arrangements.

Granules very numerous, more or less aligned on short distances, present only on the AT or the anterior half of the shell.

The hinge line has two specific characteristics: First, and paradoxically, its posterior side is relatively short (ratio D = approximatively 1 or less). Secondly, it is appreciably angled in the middle of its anterior part (and not at the level of the umbo, like in the other species).

Ocular organs observed.

Material examined and distribution: The type specimens listed- Other lots: OMAN: Gulf of Oman: 1 MNHN- MAURITIUS: 1 ZMUC- THAILAND: Phuket: 1 ANSP; 2 MNHN- THAILAND: Gulf of Thailand: 1 MHNG- MALAYA: Strait of Malacca: 1 WAM; Gulf of Thailand: 1 WAM- PHILIPPINES: 2 MNHN; 6 ANSP- HONG-KONG: 1 MNHN; 1 BM(NH)- CHINA: Hainan: 1 MNHN- JAPAN: 2 MNHN- INDONESIA: Java: 1 MNHN- MALAYA: N. Borneo: 1 ANSP- PAPUA: 1 ANSP- AUSTRALIA: 1 MNHN- Queensland: 2 MNHN;

3 ANSP- W. Australia: 1 MNHN; 3 ANSP; 1 ZMUC- NEW CALEDONIA: 9 MNHN; 3 ANSP- SOLOMON: 1 ANSP. The lots from the Eastern Indian Ocean are rather scarce, more numerous from Western Indian Ocean and Western Pacific.

Habitat: In New Caledonia it prefers littoral muddy organic environments.

Observations: *Fulvia aperta* is easily distinguished from the other species of the genus mainly by its gaping which is exceptionally absent, but also by its ribbing and the characters of its hinge.

Fulvia (Fulvia) papyracea

(Bruguière, 1789)

(pl. 1, figs. 7, 10a-b and 11a-b)

Cardium papyraceum, testa cordata, fragili etc... Chemnitz, 1782: 190, pl. 18, fig. 184 (Not binominal).

Cardium papyracea Schröter, 1788: 82 (Not binominal).

Cardium papyraceum Chemnitz: Bruguière, 1789, Vers. 1: 231.

Synonym:

Fulvia voskuili Healy & Lamprell, 1992: 89-91, pl. 4, figs. a-d. [= *F. sp.*: Lamprell et al., 1992, n° 226].

Questionable synonym:

Cardium pallidum Reeve, 1845: Sp 92, fig. 92.

Types:

Cardium papyraceum: The description of Bruguière is just a translation of Chemnitz and the only shell cited is the one figured by the latter (pl. 18, fig. 184). This **holotype** is still preserved in the ZMUC, No BIV 44, Spengler collection. The old labels indicate "Jamaica", but Chemnitz gives East Indies as locality. Dimensions: H=41.0, L=37.4, W=25.0. Angle A=125°, ratio D=1.4. With 42 ribs (pl. 1, figs. 11a-b).

Fulvia voskuili: Holotype in the QM reg. MO32906 (pl. 1, Figs. 10a-b), from Kelso Reef (N. Queensland), H=34.3, L=33.8, W=22.0, angle A= 130°, ratio D= 1.3, with 33 ribs. - **Paratype n° 1** in the AM (reg. C166907), from Dingo Beach (N. Qld.), H=31.0, L=31.0 W=20.6. - **Paratype n° 2** in the Museum of Victoria (reg. No F60471), also from Dingo Beach, H=28.0, L= 28.4, W=17.7.

Cardium pallidum: In the BM(NH), two shells are registered n° 1978.134 as **syntypes** of *C. pallidum*, considered as coming from the Bay of Manila, Philippines, Cuming collection. But,

as mentioned on the label: "none agree with figure and locality. Has been crossed out". These two shells look very much like *F. tenuicostata*, since the description, figure and locality of Reeve's specimen strongly suggest it is *F. papyracea*.

Description:

Shell of medium size, up to 45 mm in height.

Almost perfectly equilateral, rarely a little expanded backwards like the holotype. Rather depressed. No or very slight posterior truncation. Generally almost circular with L/H ratio very close to 1, the holotype being exceptionally a little elongated (L/H=0.91). No or very weak posterior groove.

Lunule large. No sublunule. Lunular heart small. Last flat relatively wide and flat. Last fold wide and flatly rounded.

External colour of the adult rather uniform, variable but almost always light, whitish to light brown, the young shell being more coloured with darker concentric stripes. Umbo often purple.

Internal colour whitish with more or less numerous brown-purple concentric stripes and often a thin radial purple line in the umbonal cavity. Almost always purple coloured in the posterior zone, this coloration being sometimes also perceptible exteriorly.

Mean number of ribs: 43 (range 37-48).

With the exception of the four or five last ribs of the PT2, the ribs are always much narrower than the interstices, which are wide and flat. In the AT, the ribs are very thin and triangular and become flatly rounded and hardly perceptible in the MT, then more perceptible in the PT1. In the PT2 the ribs are closer one from another with almost always well marked interstitial riblets. The rib features of the AT and MT are discernible internally, but at the margin itself they are of variable distinctness.

Periostracal insertions, always located in the posterior side of the ribs, form complex arrangements (pl. 1, fig. 7).

Granulation always present on the anterior half of the shell.

Hinge and dorsal margin looking symmetrical on both sides, with a mean angle A of 134° and a ratio D of about 1.3.

Ocular organs: no data.

Material examined and distribution: The holotype of *C. papyraceum*, and the holotype of *F. voskuili*. Other lots: INDIA: Gulf of Manaar: 2 ANSP- MALAYA: Strait of Malacca: 1 ANSP- SINGAPORE: 1 MNHN; 1 ANSP- PHILIPPINES: 2 ANSP; Manila: 1 QM; Subic Bay, Luzon: 1

MNHN- INDONESIA: Amboina: 1 MHNG; Yapen Island: 1 ANSP; Schouten Island: 1 ANSP- AUSTRALIA: N. Qld, Shelburne Bay: 1 QM; Gulf of Carpentaria: 1 QM.

Other lots: In MNHN, one specimen in a lot of *F. australis* labelled from Mauritius (old collection, mixing ?). In ANSP, two lots without locality (54159, 54198).

Observed also Lamarck's specimen in the MHNG (see below).

Observations: As mentioned by Chemnitz, *F. papyracea* is close to *F. aperta* in appearance: both have equivalent thinness, same colours and also approximately a same structure of ribs and interstices. But *F. papyracea* never gapes and has some other characters to distinguish it from *F. aperta*: symmetry of the shell and of the hinge, ratio D distinctly higher, lunular heart more developed, last fold and last flat wider, interstitial riblets in the PT2 more frequent. *F. papyracea* is distinguished also from *F. mutica* which is larger and of different coloration, has a smaller lunule, much wider ribs with axial periostracal insertions, very different and typical IMR, and from *F. australis* mainly by its shape and its ribbing.

The name *papyracea* is particularly erroneously used for a form of Red Sea, Western Indian Ocean and Persian Gulf, here described as *F. fragilis*, which is incontestably different (see the description of this species).

F. voskuili has all the characters of *F. papyracea*, except for the rib number of the holotype (33) which seems too low. Nevertheless three other specimens examined have: 42, 44, 47 ribs, in agreement with the range of *F. papyracea*.

Although the name *papyracea* is the most used in the literature for the different species of the genus *Fulvia* (23% of all the citations according to the chresonymy of Fischer-Piette (1977:76, 78, 79), *F. aperta* and its synonyms excluded), *Fulvia papyracea* is a rather rare species with a limited area of distribution. In the literature, the subsequent citations corresponding undoubtedly to the species in question are also extremely rare. These are:

1)- LAMARCK 1819: 6. Locality: East Indies. The shell referred to is now in the MNHG. reg. No 1085/40. It is represented by a typical right valve.

2)- REEVE 1844. Sp 9, fig. 9. Locality: East end of the Island of Luzon (Philippines). Good description and figure.

3)- HIDALGO 1903: 344. Locality: Subic Bay, Island of Luzon (Philippines). The description is excellent. No illustration given.

Fulvia (Fulvia) mutica (Reeve, 1844)
(pl. 1, figs. 5 and 12a-b)

Cardium muticum Reeve, 1844, Sp 32, fig. 32.

Synonyms:

Cardium japonicum Dunker, 1860: 223, 1861: 28, pl. 3, figs. 1-6.

Cardium annae Pilsbry, 1904: 557, pl. 40, fig. 20.

Cardium tcheliense Debeaux in Pilsbry, 1904: 558.

Types:

Cardium muticum: The only type is the specimen 67 mm long, from Cuming collection, without locality, figured by Reeve, not traced.

Cardium japonicum: The type material of Dunker is now in the Senckenberg Museum in Frankfurt (see JANSSEN, 1993). It is a shell 73 mm long, from Japan.

Cardium annae: The type specimens are two valves in the ANSP (reg. No. 86319): one left valve H= 20 mm, broken, and one right valve H=25.3, L=27.2. This right valve is figured by PILSBRY, pl. 40, fig. 20 and here in pl. 1, figs. 12a-b).

Cardium tcheliense: The specimen mentioned by Pilsbry, from China, is in the ANSP (reg. n° 54302). Its dimensions are: 24.4x26.3x17.7.

Description:

Fulvia mutica is the largest of all the known living *Fulvia*, reaching 100 mm in length.

Its shape is relatively constant, roughly "diamond-shaped", almost equilateral, often with the posterior side a little longer. Not truncated but rather a little sharpened. The length is always a little larger than the height. Shell slightly gaping in the posterior side.

Lunule small, without perilunular furrow. No sublunule. Lunular heart extremely small. Last flat narrow and a little grooved. Last fold rounded, high and well separated, bearing or not a periostracal insertion.

External colour uniform, more or less dark beige. Internal colour white to purplish pink by zones.

Mean number of ribs: 47 (range 43-54). The ribs are weak but clearly discernible in the AT and the PT1, where they are flatly rounded and about equivalent in width to the interstices. In the PT2 they are very numerous. Towards the MT, the ribs tend to be wider and flatly triangular, and become more and more indiscernible. On the other hand, in the IMR zone (which does not extend very far from the margin), the "ribs" are well and finely marked, the "interstices" being very wide.

The periostracal insertions are thick and persistent; they are generally placed on the middle of the ribs. The insertion corresponds on the other side, in the IMR, to a very thin furrow on the middle of the "interstice" (very specific character). The insertions form a simple arrangement (pl. 1, fig. 5).

Granulation often present on the lunule and the AT in the young specimens (less than 10-15 mm), but never in the adults.

Hinge indistinguished, symmetric, with an obtuse angle A (range 135-150°). The ratio D varies from 1.2 to 1.4.

Ocular organs observed.

Material examined and distribution: The type specimens of *C. annae* and *C. tcheliense*. Other lots: CHINA: 1 ANSP; Kingdao: 1 MNHN-HONG-KONG: 1 ANSP- KOREA: 1 ANSP- JAPAN: 11 MNHN; 10 ANSP.

According to KIRA (1962: 210) the species extends from South-China to Alaska. REID & SHIN (1983: 281) indicate a southern limit around Yamaguchi (Japan).

Habitat: "Muddy bottom of sheltered waters" (KIRA, 1962: 210). Kira indicates also that "This is also one of the important edible shells in Japan".

Observations: *Fulvia mutica* can easily be distinguished from the other *Fulvia* by its particular "diamond-shaped" shape, its colours, but above all by its very particular ribbing and IMR.

Fulvia (Fulvia) tenuicostata

(Lamarck, 1819)

(pl.2, figs. 1a-b)

Cardium tenuicostatum Lamarck, 1819: 5, No 5.

Synonyms:

Cardium racketti Donovan, 1826: pl.124.

Cardium radiatum Reeve, 1845: Sp 89, pl.89.

Fulvia fagea Voskuil & Onverwagt, 1992: 42 (nomen novum for the latter).

Types:

Cardium tenuicostatum: There are three lots labelled by Lamarck in the MNHN. The first lot of two specimens 50.5 and 47 mm high, from Timor and New Holland. The second and the third lots with two and one specimen respectively, are somewhat different from the first lot (smaller and more equilateral) and respectively hand-labelled by Lamarck as "var." and "individual very young". I select the largest shell from the first lot as lectotype; its

dimensions are : H=50.5, L=54.0, W=30.7; number of ribs: 47, angle A= 138°, ratio D= 1.4. (pl. 2, figs. 1a-b). The reference to Timor is very probably erroneous.

In Lamarck's collection of the MHNG, there is another specimen comparable to the main syntypes of the MNHN, but not hand-labelled by Lamarck, reg. n° 1085/38. It is 43.5x44.9x29.4, A= 140°, D= 1.2. This specimen, figured by DELESSERT (1841, pl.11, figs. 6a-c), must also be considered as a **paralectotype**.

Cardium racketti: The specimen figured by Donovan has not been traced.

Cardium radiatum: **Holotype** in the BM(NH), reg. n° 1912.6.4., from Hanley collection, locality unknown. H=32.3, L=34.3, W=23.8. Angle A=130°, ratio D=1.31. Number of ribs: 52.

Description:

Shell of medium size up to 56 mm in length, generally thick and solid in the adult stage.

Shape variable from almost equilateral to transversely and even obliquely expanded, often slightly truncated in the posterior side, which sometimes can be somewhat sharpened. Length always a little larger than height. No posterior groove.

Lunule small with no perilunular furrow. No sublunule. Lunular heart small. Last flat large. Last fold very large with two parts often separated by a small furrow: a rounded posterior part and a flat anterior one.

External colour light and uniform whitish to yellowish, rarely more or less concentrically mottled with darker colours. Umbo often purple coloured. Some specimens, a little differently coloured than usually, but in other respects typical, have been considered as specifically different (*C. radiatum* Reeve).

Internal colour white, sometimes with a red-purplish stain in the umbonal cavity and more rarely on the posterior ventral edge.

Mean number of ribs 51 (range 44-59). In the adult shells the ribs of the MT are as strongly marked as in the other two thirds. In the whole shell the ribs are equivalent in width with the interstices, or slightly wider. The ribs are generally more or less roundly triangular, often symmetrically. Rounded ribs can be present, but only in non adult shells.

According to the symmetry of the ribs, the periostracal insertions can be placed in the axis or more or less in the posterior part of the ribs. No periostracal insertion on the last fold. The nodes of the periostracal insertions never become calcified and spiny in the PT.

The granules are never abundant. They are present mainly in the young shells, in the AT.

No particularity in the hinge: mean A= 138°, mean D= 1.3.

Ocular organs observed.

Material examined and distribution: The type specimens of *C. tenuicostatum* and *C. radiatum*. Other lots: AUSTRALIA: 2 MNHN; 2 ZMUC; S.Eastern Australia: 3 MNHN; 5 AMS; 2 BM(NH); Southern Australia: 2 ANSP; 4 ZMUC; S.Western Australia: 4 MNHN; 2 AMS; 1 QM; 3 BM(NH); Tasmania: 2 MNHN; 2 QM; 2 BM(NH).

Southern Australia only. According to Wilson and Stevenson (1977: 55), "from the vicinity of Sydney on the East Coast to Fremantle in W.A".

Habitat: "Lives gregariously in sand and mud from two to 30m depth of water"(Ludbrook 1984:176).

Observations: *F. tenuicostata* differs from all the others (except *F. fragilis*) by having, when adult, a solid and thick shell with strong ribs in the MT. It is apparently close to *F. fragilis*, but both can easily be separated (see this species).

Fulvia fragilis (Forsskal in Niebuhr, 1775)
(pl. 1, fig. 6; pl. 3, figs. 1a-b)

Cardium fragile Forsskal in Niebur, 1775: 31.

Types:

Forsskal [in Niebuhr, 1775: 31] introduced the name *Cardium fragile* with the diagnosis: "*striatum transverse; tantum ad cardines laeve*". Although brief, this diagnosis qualifies as a description and the name *C. fragile* is nomenclaturally available. This opinion is shared by YARON et al. (1986: 95) who regard it as "eligible for standing as valid [taxon]". In ZMUC, there is a lot comprising 3 bivalves and one valve, originating from the Forsskal expedition to the Red Sea. This lot is without label and it is not absolutely certain that it corresponds to *C. fragile*. However, rather than naming a new species and leaving *fragile* forever in limbo, it seems preferable to stabilize this name by designating one of the Copenhagen's putative syntypes as neotype. I designate here the shell figured by YARON et al. (1986:194, fig 42) as **neotype** of *Cardium fragile*. This shell: H=23.6, L=23.0, W=15.9, with 44 ribs, angle A=120°, ratio D=1.6.

Description:

Shell of medium to large size up to 75 mm in height.

Shape generally approximately symmetrical, often with slight posterior truncation, but sometimes with the posterior part more or less transversally or obliquely expanded. Mean L/H a little higher than 1. Posterior groove weak to non existent. Sometimes very slightly gaping posteriorly.

Lunule large without perilunular furrow. No sublunule. Lunular heart variable but never large. Last flat wide and flat. Last fold very large and regularly rounded, bearing a periostracal insertion only in the young stage and in 50% of the specimens.

External colour generally uniform whitish, beige to yellowish, with a purple stain only on the umbo and sometimes on the lunular heart and on the last flat and fold.

Internally white, except on the posterior third which is almost always purple, and sometimes the umbonal cavity.

Mean number of ribs 41 (range 34-52). In the young shell, up to about 2 or 3 cm in height, the ribs of the MT are much less well marked than in the other thirds, like in the majority of the *Fulvia*, but in the fully adult shells they become as strong as the others. In the whole shell the ribs are equivalent in width with the interstices, or slightly wider. In the AT the ribs are generally rounded, but can sometimes become more or less symmetrically triangular. In the MT they become progressively asymmetrically triangular (posterior slope shorter and steeper), and can become practically flatly rounded. They remain more rounded in the PT1, but without transition they become more or less symmetrically triangular in the PT2 where the last interstices often bear interstitial riblets. In this latter area, the periostracal insertions become calcareous at the nodes, and produce tubercles or spines (pl. 1, fig. 6).

The periostracal insertions are always on the crest of the ribs in the AT; they progressively migrate to the posterior part of the ribs in the MT and also in the PT1; they migrate again on the crest of the ribs in the PT2. They form simple arrangements.

No granulation in the adult shells, but sometimes sometimes very dense on the lunule and the two or three first ribs of young specimens.

Indistinguished hinge: mean $A = 138^\circ$, mean D rather high = 1.5.

Ocular organs observed.

Material examined and distribution: The type material- Other lots: EGYPT: Mansaleh lake: 1 MNHN; Timsah lake: 3 BM(NH); Great lake: 1

ANSP; Suez canal: 1 MNHN; Gulf of Suez: 11 MNHN- ISRAEL: Elat: 1 MNHN; 1 ZMUC- Red Sea (EGYPT, SUDAN, ERITREA, ARABIA, YEMEN): 6 MNHN; 2 AMS- DJIBOUTI: Gulf of Tadjoura: 5 MNHN- YEMEN: Aden: 2 MNHN- OMAN: Gulf of Oman: 2 MNHN- South Persian Gulf (TRUCIAL COAST, QATAR, BARAIN): 3 MNHN; 3 AMS; 1 ANSP; 1 BM(NH); 5 ZMUC- N. SOMALIA: 3 MNHN- KENYA: 1 MNHN- ZANZIBAR: 1 MNHN- MOZAMBIQUE: 1 MNHN; 1 ANSP; SOUTH AFRICA: Natal: 2 MNHN; 2 BM(NH)); 2 NM- ANGOLA: Luanda: 4 MNHN- CONGO: Pointe Noire: 4 MNHN- GHANA: Accra: 1 NM- COTE D'IVOIRE: 1 MNHN.

The species migrated through the Suez Canal and is present in the Mediterranean coast of Israel, together with *F. australis* (see Barash & Danin 1992: 275). The status of the populations found in the Atlantic Ocean will be discussed by Dr. von Cosel in a separate paper.

Habitat: Littoral to shallow water.

Observations: The first figuration of this species was in SAVIGNY's plates (1805-1812: pl. 13, fig. 9). AUDOUIN (1827: 200) named these figures only: *Cardium*.... Subsequently *Fulvia fragilis* has generally erroneously been named *F. papyracea*, and sometimes *F. tenuicostata*. It differs from the former mainly by the thickness of the shell and strength of the sculpture, the larger width and different profile of the ribs and the absence of granulation, and from the latter by the lower number of ribs, the presence of rounded ribs in section, periostracal insertions situated on the posterior side of the ribs, rarely observed in the Australian species, and by some characters of the lunule and posterior flat and fold. It can be separated from *F. australis*, with which it is sympatric (except in the Atlantic Ocean), by its less oblique shape, its rounded and large instead of triangular and smaller last fold, its fewer ribs, the presence of well rounded ribs never observed in *F. australis*.

The distinction from the other species can also be helped, particularly with young specimens, by the presence in *F. fragilis* of "spines" in the PT2 and sometimes a periostracal insertion on the last fold. In other respects the young specimens seems to be variable as far as shape, proportions and colours are concerned and can look very different, from one to another and from the adults, which is often a little disconcerting.

Fulvia (Fulvia) natalensis

(Krauss, 1848)

(pl. 2, figs. 2a-b and 2c).

Cardium natalense Krauss, 1848: 12, pl.1, fig.9.*Cardium natalense* var. *adjacens* Turton, 1932: 243, No 1710, pl. 65, fig. 8.**Types:**

Cardium natalense: Krauss had only three small specimens and cited and figured one of them: H=14.6, L=16.6, W=9.0. These **syntypes** could be in the Stuttgart Museum.

Cardium natalense adjacens: Turton had only two tiny valves to define his subspecies, of which he selected the largest (6x8 mm!) as type. This **holotype** could be in the Oxford University Museum.

Remark: The present study is based on the examination of much larger and representative specimens, particularly from the lot n° 9576 Natal Museum, Kilburn collection, with numerous large specimens from Port Elizabeth (pl. 2, figs. 2a-b and fig. 2c).

Description:

Shell of medium size up to 43 mm in length.

Very inequilateral, with the posterior zone transversally expanded, rarely obliquely. Always longer than high: mean L/H= 1.12 (range 1.04-1.21). Anteriorly rounded and also posteriorly (never truncated). No posterior groove. Large posterior gape.

Lunule generally small to very small. No perilunular furrow. Lunular heart very little developed. Last flat narrow, concave. Last fold medium, flatly triangular, with always one, sometimes two, periostracal insertions.

External colour generally beige to light brown, more or less mottled with brown-purple, rather uniform, a little darker on the umbo.

Interior uniformly or irregularly dark brown-purple.

Mean number of ribs 45 (range 41-50). Ribbing rather regular, of the same strength on all the shell, the width of the ribs being everywhere equivalent to the one of the interstices, which is particularly visible in the IMR. The ribs are generally triangular and the interstices rounded. In the AT the ribs are symmetrically triangular and they become progressively asymmetric in the MT (posterior side shorter) and can become almost flat. In the PT the ribs are a little more rounded.

No granulation.

Periostracal insertions well marked, generally with predominance of the radial components, the concentric components often

being absent or very small. The insertions are situated on the crest of the triangular ribs in the AT, migrating towards the posterior side in the MT, then coming back on the crest in the PT.

Hinge line slightly arced (A range 140-150°), without any angular break (difference with *aperta*). Left anterior lateral almost confused with the margin and much more distant from the umbo than the anterior lateral (ratio D range 1.5-2.0).

Ocular organs: no data.

Material examined and distribution: S. MOZAMBIQUE: Inhambane Bay: 2 MNHN. SOUTH AFRICA: St Lucia Bay: 1 MNHN; Port Alfred: 1 NM; Jeffrey's Bay: 1 NM; Plettenberg Bay: 2 MNHN; Knysna Lagoon: 2 MNHN; 1 NM; Still Bay: 1 NM; Capetown: 1 ZMUC. Endemic of the south-Eastern coast of South Africa, from Port Alfred to False Bay.

Habitat: Mainly found in estuaries, in calm littoral waters of variable salinity, probably in muddy organic terrigenous facies.

Observations: *Fulvia natalensis*, often erroneously named as *papyracea*, has also been confused with *F. aperta* because of its gape. Nevertheless the latter differs in its less transversally expanded and less rounded shape, its lighter colour, its ribbing (ribs narrower than the interstices), its very much smaller ratio D, its larger lunule and its high and narrow last fold without periostracal insertions.

Fulvia (Fulvia) australis

(Sowerby, 1834)

(pl. 2, figs. 3a-b, 4, 5 and 6a-b)

Cardium australe Sowerby, 1834: fig. 12 and 1840: 105.

Synonym:

Cardium striatum Spengler, 1799: 45.

Questionable synonyms:

Cardium varium Sowerby 1834, fig 19.

Cardium pulchrum Reeve 1845, Sp 98, fig 98.

Types:

Cardium australe, *varium*, *pulchrum*: No type specimen referred to these three nominal species.

Cardium striatum: Two **syntypes** in ZMUC, Spengler collection, from South Seas. N° 1: 24.4x25.1x17.0, 50 ribs. N° 2: 23.8x23.8x15.5, 55 ribs.

Remark: The name *Cardium striatum* has priority over *C. australe*, but *australe* is used because: (a) *striatum* has never been used subsequently to Spengler, other than FISCHER-

PIETTE (1977: 160) in a list of "uncertain species"; (b) *australis* has been used over 50 times since its description, and is currently the second most widely used specific name in the genus *Fulvia*. (An application to conserve the name *F. australe* will be presented to the International Commission on Zoological Nomenclature).

Description:

Shell of medium size, up to 35 mm in height. The shells are generally thin, but rarely excessively, and are relatively solid.

Shape sometimes almost equilateral but generally obliquely ovate, inequilateral, with the dorsal anterior part inflated and the posterior part more or less obliquely expanded. Almost always slightly truncated in the PT2. Posterior groove generally well developed.

Lunule of medium size with a small lunular heart. Perilunular groove sometimes present. Sublunule often present but always short (equivalent of two or three ribs in length). This zone is very often red coloured, and bears periostracal insertions (it is therefore more easily discernible in the IMR). Last flat medium, sometimes concave. Last fold markedly triangular, mainly in the young shells, with no periostracal insertions.

Exterior colour very variable from pure white to dark brown purple. The young specimens (and the early formed part of the adult shells), are often more coloured, with generally darker, irregular, more or less concentrically arranged stains of variable density. The interstices are not stained, or are lighter coloured than the ribs.

Interior generally white to yellow or light pink, with the exterior darker stripes transparently visible and also some radial rays. Rarely presence of a slight reddish coloration in the posterior side.

The mean number of ribs is 49, but this number is extremely variable (range 34-68) between areas and populations (see below).

The ribs are similar and homogeneous in AT and MT, weakly marked, equivalent in width to the interstices or a little narrower, flat or very slightly rounded; interstices flat. In these two zones the IMR is also homogeneous and well marked. In the PT1 the ribs and interstices become irregular and the interstices become very wide with regard to the ribs which take a triangular profile. Interstitial riblets in the PT2 often present, but more or less well developed.

The periostracal insertions are always situated on the posterior limit of the ribs in the

AT and MT, but tend to migrate to the crest of the triangular ribs in the PT.

Granulation of variable density, on individuals and populations, sometimes lacking, generally limited to the anterior half of the shell, on the ribs as well as in the interstices, sometimes aligned but always on short distances.

Hinge line and dorsal margin characteristically asymmetric, with a receding posterior side and a raised and inflated anterior one, forming a vague angle like a hump. Angle A relatively "acute", mean value 133° (range 130-140), and ratio D rather high: mean 1.3 (range 1.2-1.5).

Ocular organs observed.

Material examined and distribution: The syntypes of *C. striatum*- Other lots: EGYPT: Gulf of Suez: 5 MNHN; Marsa Thlemel: 1 MNHN- ISRAEL: Elat: 1 ZMUC- DJIBOUTI: 2 MNHN- N. SOMALIA: 1 MNHN- OMAN: Gulf of Oman: 1 MNHN- ARABIA: S. Persian Gulf: 1 MNHN- KENYA: 1 MNHN- ZANZIBAR: 1 MNHN- TANGANYIKA: Dar-es-Salaam: 1 AMS- MOZAMBIQUE: Vilanculos: 1 MNHN- MADAGASCAR: E. coast: 5 MNHN; Dredging Tulear: 51 MNHN - MAURITIUS: 9 MNHN; 1 ZMUC- SEYCHELLES: 1 MNHN- INDIA: Gulf of Manaar: 2 ANSP- W. THAILAND: Phuket: 2 MNHN; 1 ZMUC; 1 ANSP- MALAYA: Tocal: 1 ZMUC- VIETNAM: 1 MNHN; Poulo Condor: 2 MNHN; Natrang Bay: 1 ZMUC- CHINA: 2 MNHN- JAPAN: 1 MNHN- PHILIPPINES: Manila 1 MNHN; Luzon: 1 WAM- AMER. PAC. TRUST TERR.: Nukuoro Atoll: 1 WAM- INDONESIA: Molucas, Cayeli: 1 MNHN- PAPUA: Hansa Bay: 2 IRSNB; Madang: 1 WAM- SOLOMON: 1 ANSP; 1 QM; 1 WAM- GILBERT: Kiribati: 1 AMS- TONGA: 1 MHNG; 1 WAM- FIJI: 3 MNHN; 1 WAM- VANUATU: 2 MNHN- NEW CALEDONIA: 113 MNHN; 2 ANSP- AUSTRALIA: 1 MNHN; Queensland: 2 MNHN; 2 AMS; 5 QM.

Found in the Suez canal and in the Mediterranean coast of Israel and Palestine, together with *F. fragilis* (see BARASH & DANIN, 1992: 275-276).

Habitat: littoral to shallow water. Seems to prefer clean reefal or perireefal facies.

Observations: *Fulvia australis* is the most common and widespread species of *Fulvia* and can be sympatric with almost all the others. It can easily be differentiated mainly by its very characteristic oblique asymmetry and the strong contrast between the ribbing in the AT and MT, dense, serried, regular and homogeneous, and the ribbing in PT, loose and irregular. As a

matter of fact it has not often been confused with the other species, unless in very young specimens. Nevertheless, in spite of its constant characters allowing always an accurate identification, this species can be variable in shape, colour and number of ribs.

A good illustration of this variability can be found in New Caledonia, where very numerous lots of this species are available, from several environments. It is possible to distinguish three forms:

1)- Forms comparable to the types of Sowerby and Reeve: shells of rather small size, slightly asymmetric, rather depressed (mean $W/L = 0.65$), strongly coloured outside and inside, with a small number of ribs (34 to 44). They are found mainly in the lagoon of the Ouvea atoll, at water depths from 10 to 20 meters. Such forms (with more ribs) exist locally in Australia, and sporadically elsewhere as individual variants. A specimen from a lot close to this form, from Shelburne Bay, North Queensland, lot QM No 45517, is figured here in pl. 2, figs. 6a-b: $H=26.5$, $L=24.8$, $W=17.0$, with 55 ribs.

2)- (pl. 2, fig. 5), shells of average size, mainly asymmetric, fairly depressed (mean $W/L = 0.70$), coloured by irregular concentric stripes of brown or purple (ribs only coloured, not interstices), and frequently with the umbo, the sublunule and the lunular heart purple coloured, an average number of ribs (40-55). Mainly in littoral zones. This form is the most common form of the species, found everywhere, more or less coloured, sometimes entirely white (see also pl. 2, fig. 4 an intermediate form).

3)- (pl. 2, figs. 3a-b), shells of rather large size for the species, almost symmetric, more globular (W/L up to 0.80), lightly coloured with or without darker stripes, with a large number of ribs (50-68), and no or rare granules. They are found mainly in the lagoon at water depths from 15 to 80 meters and exceptionally in the littoral zones. Comparable forms are also present in the coast of East Africa, islands of the Indian Ocean, Melanesia, China.

This differentiation in New Caledonia suggests the existence of a significant influence of the environment on certain characters of this species. Nevertheless, the above three forms cannot be considered as subspecies because of their geographical dispersion and the existence, even at the populational level, of many intermediate forms.

Fulvia (Fulvia) fragiformis sp. nov.
(pl. 3, figs. 2a-b)

Types:

The only known four shells, in MNHN, from New Caledonia. **Holotype:** Found alive near Abore reef ($22^{\circ}47' S-166^{\circ}40' E$), Depth 15m, $H=16.5$, $L=15.7$, $W=11.2$, with 52 ribs. Angle $A=150^{\circ}$, ratio $D=1.4$. (pl. 3, figs. 2a-b). **Paratype n° 1:** Dredged in the SE lagoon, sta.731 ($21^{\circ}17'2 S-165^{\circ}52'0 E$), depth 40m, $H=12.1$, $L=11.0$, $W=9.0$, with 49 ribs. **Paratype n° 2:** Dredged in the S lagoon, sta.589 ($22^{\circ}31'7 S-167^{\circ}23'0 E$), depth 31m $H=11.1$, $L=10.6$, $W=7.4$, with 45 ribs. **Paratype No 3:** A left valve dredged in the SW lagoon, sta.21 ($22^{\circ}22'1 S-166^{\circ}23'4 E$), depth 16m, $H=16.6$, $L=16.8$, $1/2W=5.3$, with 46 ribs.

Description:

Shell small, the paratype No 3 being the largest, thin and fragile.

Very special shape comparable to some FRAGINAE, with the PT in a different plane and separated by a rounded angle. This PT is largely reduced. In consequence of these particular features, the shell has an uncommon asymmetry, with the anterior half longer than the higher posterior half. Posterior groove present, well marked in the interior of the shell.

Lunule small, without perilunular furrow. Lunular heart very small. No trace of coloured sublunule. Last flat small, slightly concave. Last fold large, almost flat.

External colour white to yellowish, with more or less zigzagging irregular brown-purple concentric stripes. A brown spot on the umbo.

Internal colour similar by transparency.

Number of ribs 45 to 52. In the AT and the MT the ribs are mainly flat rounded and roughly equivalent in width between themselves, the interstices being a little wider than the ribs, particularly in the AT. In the PT1 the ribs and interstices are equivalent and wider, the ribs being rounded to flatly triangular. In the PT2 the ribs become more triangular with, in the smallest specimen, interstices wider and flat. In all specimens the IMR is very little marked in the PT2.

Periostracal insertions strong, situated on the posterior side of the ribs in the AT and MT, then on the middle of the triangular ribs in the PT, with the nodes sometimes a little calcified.

Granulation present, but not very abundant in the AT and sometimes in the PT.

Hinge thin with small teeth.

Ocular organs observed.

Material examined and distribution: The type material.

Habitat: Shallow water in clean non terrigenous facies.

Observations: *Fulvia fragiformis* is very close to *F. australis*, except for its very characteristic shape, never observed in the latter. There are also slight differences in the ribbing and the IMR (a little less marked), in the thicker periostracal lamellae, and in the stronger granules in *F. fragiformis*.

***Fulvia (Fulvia) boholensis* sp. nov.**
(pl. 3, figs. 6a-b)

Types:

The type series in the MNHN. **Holotype:** from Panglao, Bohol Island, Philippines. It is said to have been recovered at 80 fms. Dimensions: H=36.0, L=35.2, W=21.6. Angle A=130°, ratio D=1.2, 55 ribs (pl. 3, figs. 6a-b). **Paratype n° 1:** From Philippines, without precise data, H=33.5, L=34.0, W=21.1. Angle A=130°, ratio D=1.2, 54 ribs. **Paratype n° 2:** From Sulu Sea, Philippines. H=33.3, L=35.1, W=20.8. Angle A=130°, ratio D=1.1, 52 ribs. **Paratype n° 3:** From Philippines, without precise data, H=28.0, L=27.4, W=17.2. Angle A=130°, ratio D=1.2, 50 ribs.

Description:

Shell of medium size, up to 36 mm in length, relatively thin and fragile.

Always significantly asymmetric, obliquely expanded backwards, truncated in the PT2, rather depressed (mean W/L=0.62). Posterior groove well developed.

Lunule medium with a small lunular heart. Sublunule often present but always very short (like *F. australis*). Last flat medium. Last fold flatly triangular with no periostracal insertions.

Colour almost always orange or yellowish-orange internally and externally, the umbo and margins often being darker. The lighter medial zone of the shell often bears a little darker irregular concentric stripes. Some rare specimens (like paratype No 3) have "normal" colours: beige, light brown, purple, a part of the internal PT only being orange. The only observed specimen from outside of the Philippines (Western Australia) is yellow-orange with white margins.

Mean number of ribs 51 (range 47-55).

Ribs a little triangular in the AT, with wider interstices, flat or flatly rounded in the MT, with interstices about equivalent in width,

slightly triangular with wider interstices in the PT2. IMR extending far from the margin, often not perfectly marked in the MT which has a thin and fragile margin.

Periostracal insertions of rather complex arrangement, situated on the posterior side or on the crest of the ribs. One of the radial components of these insertions become calcified and form, at each node, a thin oblique often elongated tubercle, in the PT.

Granules numerous in the anterior half of the shell, often aligned on short distances.

Ocular organs: no data.

Material examined and distribution: The type specimens and four corresponding lots. Other lots: PHILIPPINES: Bohol: 1 QM-AUSTRALIA: Western Australia, Dampier: 1 QM.

Observations: *Fulvia boholensis* seems to be an intermediate form between *F. australis* and *F. papyracea*. It differs from the former by its ribbing, particularly its IMR which is smoother, from the latter by its ribbing and its asymmetry. It differs from both by its particular colours, and also from all *Fulvia* by the particular arrangement of the periostracal insertions in the PT forming elongated carbonaceous tubercles. (The equivalent tubercles of *F. fragilis* are different and not elongated).

***Fulvia (Fulvia) dulcis* (Deshayes, 1863)**
(pl. 1, fig. 8; pl. 2, figs. 8a-b)

Cardium dulce Deshayes, 1863: 12, pl. 29, figs. 3-5.

Types:

Four syntypes in the MNHN from Réunion, 12.0 to 7.1 mm in height. The largest: H=12.0, L=11.5, W=8.7, with 41 ribs, is selected here as **lectotype** (pl. 2, figs. 8a-b).

Description:

Shell small, the above lectotype being the largest specimen observed.

Shell roughly equilateral, with the anterior margin rounded and the posterior one a little straightened. Almost circular, with L/H close to 1. Presence of a weak posterior groove corresponding inside to a well marked ridge.

Lunule of medium size, without perilunular furrow. Lunular heart rather large. Presence of a long sublunule, about equivalent in length to the lunule. Last flat small. Last fold very large, a little rounded to flatly triangular (pl. 1, fig. 8).

External colours: in the Indian Ocean the shells are whitish with a pink coloration in the umbo, diminishing towards the margin, forming a few irregular concentric stripes more or less zigzagging. The AT and PT zones are also light pink. Some specimens are entirely white. In the Pacific, same coloration but light brown instead of pink.

Interior with same colours by transparency.

Number of ribs: 41 to 47. The ribs of the AT and MT zones are equivalent in width with the interstices. They are flatly rounded, low, and hardly perceptible with the naked eyes, with no difference between these two zones. The IMR of the above zones is also regular, well perceptible, extending far from the margin which is also distinctly serrated. In the PT1 the ribs become suddenly wider and stronger, with equivalent interstices. They are also well marked, but smaller and more numerous, in the PT2 with possibly some interstitial riblets. In the lunule and sublunule, the growth lines form very thin concentric folds.

Periostracal insertions (3 to 5) without ribs in the sublunule. Present also in the AT and the MT and situated on the posterior limit of the ribs. The insertions migrate to the axial part of the ribs in the first ribs of the PT, then can disappear: in that case some ribs of the PT do not bear any insertion, or rudimentary ones.

Granules often numerous, but never aligned, on the posterior side of the shell, even on the posterior flat and fold (pl. 1, fig. 8); they are rarer on the anterior part. They can be totally absent from the whole shell.

Hinge with no particularities, with both sides almost symmetric.

Ocular organs observed.

Material examined and distribution: The type specimens- Other lots: SOUTH AFRICA: Zululand: 10 NM- PAPUA: Hansa Bay: 1 QM- NEW CALEDONIA: 33 MNHN.

Habitat: In Réunion, according to DRIVAS & JAY (1988: 16), it is "found alive in muddy black sand at 12 to 30 m depth".

In New Caledonia also it is exclusively present in shallow terrigenous facies, East of the island, between 20 and 50m. In South Africa it was dredged in fine sandy facies between 45 and 50 m depth.

Observations: *F. dulcis* is easily distinguished from several small forms of *Fulvia* by its periostracal insertions, and from the young specimens of *F. australis* by its more equilateral and globular shape and by its longer sublunule.

***Fulvia (Fulvia) scalata* sp. nov.**

(pl. 1, figs. 3 and 4; pl. 3, figs. 5a-b and 7)

Types:

Types from the eastern lagoon of New Caledonia. **Holotype:** In the MNHN, sta. 833 (20° 27'6" - 164° 44'3"), depth 27m, H=19.1, L=19.3, W=14.8, with 46 ribs, (pl. 3, figs. 5a-b). **Paratype n° 1:** In the MNHN, same sta. as holotype, H=17.6, L=18.4, W=12.7, with 43 ribs. **Paratype n° 2:** In the MNHN, sta. 883 (20° 27'6" S-164° 44'3" E), depth 27m, H=17.1, L=17.2, W=12.4, with 42 ribs. **Paratype n° 3:** In the MNHN, sta. 873 (20° 38'55" S-164° 46'2" E), depth 27m, H=15.0, L=15.2, W=11.5, with 37 ribs. **Paratype n° 4:** In the MNHN, sta. 847 (20° 37'65" S-165° 13'4" E), depth 28m, H=11.0, L=11.1, W=8.3, with 38 ribs. **Paratype n° 5:** In the AMS, same sta. as holotype, H=16.6, L=16.8, W=11.1, with 48 ribs. **Paratype n° 6:** In the ANSP, same sta., H=17.7, L=17.8, W=13.0, with 51 ribs. **Paratype n° 7:** In the NMNZ, same sta., H=17.3, L=16.7, W=12.7, with 45 ribs.

Description:

Shell small, the holotype being the largest specimen observed.

Roughly equilateral, with the anterior margin rounded and the posterior one a little straightened. Almost circular, with L/H very close to 1.0. Presence of a very weak posterior groove, only in adult shells.

Lunule rather small, without perilunular furrow. Lunular heart extremely large, the largest of all the *Fulvia* (pl. 1, fig. 3). Presence of a sublunule of rather variable length, but never as long as the lunule (varying between 1/2 and 3/4 of the lunule), with no periostracal insertions but sometimes with a rudimentary rib in its middle. Last flat extremely large, sometimes divided into two differently tilted zones. Last fold also extremely large with a posterior triangular part and a flat large anterior one.

External colour generally white to light brown, rarely with concentric irregular darker stripes. Umbo and posterior part often darker coloured.

Internally, the umbonal cavity is often yellow to pinkish and the posterior part slightly purple.

Number of ribs about 40 (range 36-44). With the exception of the PT2, the ribs are strictly equivalent in width to the interstices. The ribs, well rounded in the AT, then becoming more or less flatly rounded or flat in the MT, are well delimited, contrasting with the

flat interstices. The ribs are weaker in the MT but always well perceptible in the adult shells. In the PT1 the ribs and interstices are a little wider and stronger than in the other parts of the shell. In the PT2 the interstices are very narrow, the two last ribs being very large and flat, and the others narrow and a little triangular. The IMR is very well marked and extended. In the lunule and sublunule, the growth lines form thin concentric folds.

Periostracal insertions situated on the posterior limit of the ribs in the AT and MT, then migrating progressively to the top of the ribs in the PT.

Granulation almost always present both in the anterior half, including the lunule, and in the posterior half, including the last flat and fold. In the AT and PT1, the granules are located in the interstices, aligned and placed at more or less regular intervals, like rungs in a ladder (scalata). In the very young shells, granulation can also be developed in the MT, forming irregular concentric lines (pl. 1, figs. 4 and pl. 3, fig. 7).

Hinge typical of the genus, very asymmetric as far as laterals are concerned ($D=1.7$ to 1.8), with a particular triangular nymph strongly projecting exteriorly beyond the margin of the shell.

Ocular organs observed.

Material examined and distribution: The type series- other lots: OMAN: Mascate : 1 MNHN- MADAGASCAR: Tuléar: 4 MNHN- PHILIPPINES: Visayas and Luzon: 2 MNHN, 1 WAM- INDONESIA: Macassar Strait: 1 MNHN; Moluccas 1 WAM- PAPUA: Hansa Bay: 3 IRSNB- NEW CALEDONIA: 75 MNHN- AUSTRALIA: Queensland: 7 AMS; Carpentaria: 1 QM; Western Australia: Dampier: 1 QM; i WAM.

Habitat: In New Caledonia only found in shallow water from 20 to 50 m (never littoral), and in the terrigenous sandy facies of the Eastern coast (rarely in clean perireefal facies).

Fulvia (Laevifulvia) undatopicta

(Pilsbry, 1904)

(pl.1, figs.1 and 2; pl. 2, figs.9a-b, 10 and 11)

Cardium hungerfordi undatopictum Pilsbry, 1904: 556, pl. 40, figs. 14-15.

Cardium undatopictum Pilsbry: Nomura & Niino, 1940: 55.

Synonym:

Cardium hungerfordi stigmaticum Pilsbry, 1904: 556, pl. 41, figs. 13-14.

Types:

Cardium hungerfordi undatopictum: **Syntypes** in the ANSP, reg. n° 80521: from Hirado, Hizen, Japan (Hirase collection, 1901), four paired specimens and one right valve, from 11.6 to 18.3 mm in height. The largest ($H=18.3$, $L=17.5$, $W=10.5$), with 48 ribs, is figured by Pilsbry and here in pl. 2, figs. 9a-b.

Cardium hungerfordi stigmaticum: **Syntypes** in the ANSP, reg. n° 86.279: also from Hirado, Hizen, Japan, three paired specimens from 10.5 to 11.7 mm in height. The largest ($H=11.7$, $L=11.0$, $W=7.5$) is figured by Pilsbry and here in pl. 2, fig. 11.

Description:

Shell small. The first syntype above cited being the largest observed.

Generally roughly equilateral, rarely appreciably obliquely inequilateral (like some syntypes). Often slightly truncated posteriorly, sometimes with a small open indentation in the margin corresponding with the posterior groove which is more or less developed. Shell a little higher than long: L/H range 0.88-0.93.

Lunule of medium size with a rather small lunular heart (pl. 1, fig 2), both not coloured. Sublunule long, length equal to the lunule (pl. 1, fig. 1).

External colour very variable from pure white to almost entirely dark brown purple. Often whitish to beige with more or less developed irregular brown red stripes or zigzags. Sometimes only coloured by small spots. Four different red stains can be present, often together, forming a cross: one stain on the umbo, another one radially elongated in the middle of the shell (the variety *stigmaticum* of Pilsbry is a pure white form with only these two stains, see pl. 2, fig. 11), a third one on the sublunule, and the last one on the posterior margin on the PT2 zone. In the syntypes of *undatopicta*, these stains are not present, or extremely pale.

The internal colours are the same, by transparency.

Mean number of ribs about 48 (range 46-53), with 10 in the PT. From the medio-posterior part of the MT, where the ribs are present but not easily discernible, they become progressively a little more developed and wider towards the AT where, however, they remain of moderate development. Towards the PT, the ribs evolve in the same way, but they become quickly well marked and wider in this zone. They are generally flatly rounded, except in the PT2 where they become somewhat triangular, and equivalent in width with the

interstices. The IMR is always clearly discernible and shows the same evolutions as the external ribbing. Interstitial riblets present in the PT2, where the ribs tend to be very wide close to the posterior margin. In the sublunule and the posterior part of the lunule, the growth lines tend to form thin concentric folds.

No periostracal insertions.

Granules more or less abundant, but always present, concentrically aligned on long distances in the AT (pl. 2, fig. 10), rare to absent in the MT, more or less abundant and not aligned in the PT.

Hinge characteristic of the genus, regularly curved. Nymphal plate narrow, not triangular.

Ocular organs observed.

Material examined and distribution: The type material- Other lots: Red Sea: 4 MNHN- EGYPT: Gulf of Suez: 2 MNHN- DJIBOUTI: 1 MNHN- YEMEN: Aden: 1 MNHN- MADAGASCAR: Dredging Tulear: 8 MNHN; Nosy Bé: 1 MNHN- THAILAND: Kut Is: 1 AMS- PHILIPPINES: Visayas: 1 MNHN- JAPAN: Tosa: 1 MNHN- PAPUA: Hansa Bay: 1 IRSNB; 1 QM- NEW CALEDONIA: 232 MNHN - AUSTRALIA: Queensland: 5 AMS; Gulf of Carpentaria: 1 AMS.

Habitat: Only shallow water, rarely littoral. In New Caledonia, lives in reefal or perireefal calcareous facies, between 10 and 35m.

Fulvia (Laevifulvia) lineonotata sp. nov.
(pl. 3, figs. 4a-b)

Types:

Types from New Caledonia. **Holotype:** In MNHN, sta.992 (20°16'1 S-163°56'6 E), depth 28 m, H=13.6, L=11.1, W=8.2, with 52 ribs (pl. 3, figs. 4a-b). **Paratype n° 1:** In MNHN, same sta. as holotype, H=8.9, L= 8.0, W= 5.2. **Paratype n° 2:** In MNHN, Chesterfield lagoon sta.DW 31 (19°24'86 S-158°45'03 E), depth 57m, H=10.2, L= 9.6, W=6.3. **Paratype n° 3** in MNHN, Chesterfield lagoon sta DW 50 (19°18'30 S-158°33'57 E), depth 50m, H=10.2, L=9.6, W=6.1. **Paratype n° 4:** In MNHN, Chesterfield lagoon sta.DW40 (19°29'46 S-158°35'27 E), depth 58m, H= 9.7. L=8.7, W=6.0. **Paratype n° 5:** In AMS, sta.1174 (19°21'3 S-163°14'2 E). depth 53m, H=10.2, L=9.2, W=6.1. **Paratype n° 6:** In ANSP, same sta. as holotype, H=9.0, L=8.2, W=5.3. **Paratype n° 7:** In NMNZ, sta.542 (19°06'4 S-163°10'0 E). depth 50m, H=10.0. L=9.1. W=6.0.

Description:

Shell small about 10mm in height, the holotype of 13.6 mm being the largest observed.

Always a little elongated (L/H between 0.84 and 0.94). Asymmetric with the anterior margin rounded and the posterior margin a little obliquely expanded, with a small depression at the extremity of the posterior groove, which is weakly but always developed.

Lunule rather small without lunular heart and with no or very small perilunular furrow, limited by a coloured line formed by triangular spots. Presence of a very long sublunule (1.5 times or more the lunule), the longest of all the *Fulvia*.

External coloration constituted by juxtaposed or imbricated differently coloured (white to brown purple) triangles, with more or less diffuse limits. The posterior part of the MT is marked by a radial alignment of darker coloured triangles, alternating with white ones. This coloured "line", almost always perceptible, gave its name to the species. Umbo and often posterior margin stained red purple.

Internal coloration the same as the external one by transparency.

Ribs almost indiscernible in the AT and MT, but the IMR, limited to a small band, is clearly discernible and allows counting of about 40 ribs in these two zones. The PT bears about 13-15 well marked ribs, flatly triangular, with narrow interstices. The narrowest ribs (about four in number) are located in the anterior part of the PT2. These ribs are often poorly marked and can disappear. Except in the PT, the growth lines form very thin concentric folds.

No periostracal insertions.

Thin granules, often concentrically aligned, on all the anterior half of the shell including the lunule.

Hinge very thin, particularly the nymphal plate, and well arched. Angle A of medium value for the genus, and ratio D higher than 1.0.

Ocular organs observed.

Material examined and distribution: The type material- Other lots: MAURITIUS: Port Louis: 1 NM- INDIA: Maldives, Milandu Atoll: 1 BM(NH)- NEW CALEDONIA: 45 MNHN.

Habitat: in New Caledonia exclusively shallow water, in clean calcareous facies from 25 to 60m.

Observations: *Fulvia lineonotata* is easily separated from the other small *Laevifulvia* by its elongated oblique shape, its particular colour pattern, its long sublunule.

Some small specimens of *Laevicardium lobulatum* Deshayes, 1855, which are sometimes sympatric in New Caledonia, can have approximately the same shape and colours, and easily be confused. Nevertheless, the latter has still less perceptible ribs in the AT and MT and no ribs in the PT2, many more "ribs" in the IMR (about 85 versus 55), a shorter sublunule and no granules. In addition the umbo of this species bears a special reticulated ornamentation, never observed in any *Fulvia*, and it never has ocular organs.

Fulvia (Laevifulvia) hungerfordi

Sowerby, 1901

(pl. 2, figs. 12a-b, 13, 14 and 15)

Cardium (Papyridia) hungerfordi Sowerby, 1901: 103, pl. 9 fig 5.

Types:

Three **syntypes** from Japan, preserved in the BM(NH), reg. 1902.5.28.5.7, respectively 9.0, 8.4 and 8.0 mm in length. The two latter are figured here pl. 2, figs. 12a and 12b.

Description:

Shell small up to 14 mm in length.

Always longer than high (L/H range 1.02 to 1.16). Generally inequilateral with the posterior part expanded, but never obliquely; nevertheless Indonesian forms are quasi-perfectly equilateral. Posterior margin a little truncated in the PT2, and PT1 often lengthened, overstepping a little the margin of the shell; some slight straightenings in the ventral and anterior margins can give the shell like a vague "polygonal" aspect, with a sharpening in the posterior margin. Posterior groove weak but well marked in the early stage of growth, disappearing in the adult shell.

Lunule medium, flat or a little concave, limited by a significant rounded ridge, clearly delineated also in the early stage of growth. Lunular heart small. Sublunule of variable length, according to the different populations (between one half and almost one and a half times the length of the lunule). Last flat large, a little concave. Last fold large, flatly triangular.

Colour of the shells, external and internal, uniform, from beige to brown or red purple, becoming lighter towards the margins.

About 10 ribs in the AT, 12 ribs in the PT and 20-22 ribs in the MT when this third is ribbed. The ribs are generally equal in width with the interstices, except in the PT2 where the interstices are very thin. In the AT the ribs have

a rounded or slightly flatly rounded profile and the interstices are flat. In the PT1 the ribs and the interstices, the largest of all the shell, both have a rounded profile. In the PT2 the ribs flatten. As far as the MT is concerned, it can be entirely ribbed like the AT, or partially ribbed, or not ribbed, according to populations (see later). In all the forms, the growth lines form, in the adult shells, more or less strong concentric folds, except in the PT.

No periostracal insertions.

Granulation of variable density (sometimes absent) on the whole shell, sometimes perfectly concentrically aligned in the MT.

Hinge with no particularities.

Siphonal eyes present according to REID & SHIN, 1983: 277, fig. 1.

Material examined, distribution and observations : Observed specimens from four areas:

JAPAN: Syntypes and specimens of the ANSP cited by PILSBRY (1904: 555, pl. 41, fig. 17). Inequilateral forms with no ribbing in the MT. Found in littoral and shallow water in organic muddy facies. Recorded also from Hong Kong (REID & SHIN, 1983: 275), but with no data about the shell itself.

PHILIPPINES: One lot from Musorston Campaign 1985, sta. DR 140, Jintololo channel, North of Panay Island, depth 93-99m in clean muddy and shelly facies (thanatocenosis). Inequilateral forms with partial variable development of ribs in the MT (pl. 2, fig. 13).

INDONESIA: Two lots from Siboga Expedition: sta.53, North of Sumba Island, depth 36m in coral sand and sta.174, East of Ceram Island, in very shallow reef facies. In both areas the shells are almost equilateral with ribs in the MT (pl. 2, fig. 14).

NEW CALEDONIA: Only in one locality: Gatope Beach, near Voh, in the North-Western coast, littoral in deltaic argillaceous sandy facies. Asymmetric forms with ribs in the MT (pl. 2, fig. 15).

***Fulvia (Laevifulvia) prashadi* sp. nov.**

(pl. 3, figs. 8a-b)

Types:

In the ZMA, from Siboga expedition, sta.71, South of Macassar Strait, Indonesia, depth 32m, in mud, sand with mud and coral. Identified as *Cardium hungerfordi* Sow by PRASHAD (1932: 281). **Holotype:** A right valve H=10.2, L=10.2, 1/2W=0.4 (pl.3, figs. 8a-b). **Paratype n° 1-** A left valve H=9.3, L=9.3,

1/2W=0.37. **Paratype n° 2-** A right valve H=9.0, L=9.0, 1/2W=0.35. **Paratype n° 3-** A left valve H=7.5, L=7.7, 1/2W=0.3.

Description:

Shell small, the holotype being the largest known specimen.

Shape relatively constant, inequilateral, with the anterior side short and slightly truncated and the posterior one not obliquely expanded. Often the MT margin is straightened in its posterior part. The PT is sharpened and clearly isolated from the rest of the shell by a significant notch in the margin, the PT forming a ridge making the margin pointed.

Lunule medium, a little concave, limited by a rounded ridge well delineated, even in the earliest stage of growth. Lunular heart small. Sublunule equivalent to the lunule in length, or a little longer. Last flat large, a little concave. Last fold large, flatly triangular.

External colour uniformly light beige. Internally yellow, lighter in the axis of the umbonal cavity, with the posterior part a little purplish.

About ten ribs in the AT equivalent in width to the interstices, with a well marked IMR. No ribs nor IMR in the MT.

About ten strong ribs in the PT, equivalent in width to the interstices in the PT1, wider in the PT2, corresponding to a strong IMR. In the whole shell, presence of well marked rounded concentric folds, corresponding to the growth stages.

No periostracal insertions.

Never seen any granulation on the few specimens observed.

Hinge with no particularities.

Ocular organs: no data.

Material examined and distribution:

Found only by the Siboga expedition in Indonesia in five stations: sta. 71, South of Macassar Strait near Sulawesi coast: eleven valves (type series) sta.4, East Java, depth 9m in coarse sand: 1 specimen and one valve - sta.33, East Lombok Island, depth 22m in mud, coral and coral sand: one specimen - sta.164, South of Salawati Island, North East New Guinea, depth 32m in mud, sand and coral: one specimen - sta.114, North coast of Sulawesi, depth 75m in very fine hard sand: one specimen.

Observations: *Fulvia prashadi* is close to certain forms of *F. hungerfordi* and could be considered as a special form or a subspecies of the latter. The problem needs more material to be solved. In favour of a specific separation is the fact that the only two known sites of *F.*

hungerfordi in Indonesia (Siboga sta. 53 and 174) are close to sites of the former, and contain quite different symmetrical specimens (pl. 2, fig. 14), constant in characters. It is the same for *F. prashadi* which shows very constant characters in the five sites where it is found in Indonesia. Anyway, I think that these very special forms merit a new name (species or subspecies).

Fulvia (Laevifulvia) ballieni sp. nov.

(pl. 3, figs. 3a-b)

Type:

Holotype in the MNHN labelled "Sandwich Islands, Mr Ballien 1876". It may seem improbable that such a large and remarkable Hawaiian bivalve has remained unknown to this date. Indeed, that it is known from a single shell, collected in the 19th century, in a European Museum, is suspect. No *Fulvia* or *Laevicardium* is known from Hawaii, and there is no material in the Bishop Museum (KRASLOWITZ, pers. comm.). I cannot exclude the possibility that the shell of *F. ballieni* has been erroneously labelled and in fact it does not originate from Hawaii. However, there are indications in the catalogue of the MNHN that a Mr Ballien did send repeatedly shells from Honolulu between 1872 and 1878. *Fulvia ballieni*, be it Hawaiian or not, must be a rare species, as evidenced by the fact that no other specimen has shown up since Ballien's collect in 1876.

Description:

Shell of medium size: H = 48.0, L = 49.3, W = 34.3.

Practically equilateral, but with a very small double-truncation making the PT slightly sharpened. No gaping.

Lunule not separated from the sublunule, which is a little shorter than the lunule. Lunular heart very small. Last flat hardly differentiated, a little concave. Last fold narrow, triangular.

External colour uniformly light beige, shining. Interior whitish, with the margin yellowish.

Number of ribs 50. The ribs and interstices are hardly marked on the whole shell, a little more in the PT1. No ribs in the PT2 which is smooth, externally and internally. The IMR, which extends rather far from the margin, is very better marked than the ribbing and shows "ribs" a little narrower than "interstices".

No periostracal insertions.

Granules more or less aligned present only on the umbonal part up to about one centimetre from the umbo.

Hinge typical of the genus. Angle A = 130°. Ratio D = 1.32.

Ocular organs: no data.

Material examined and distribution: Only the holotype, maybe from Hawaii.

Observations: Shining apart, *Fulvia ballieni* has approximately the same appearance as *F. mutica* from which it differs by many other characters (no periostracal insertions, rather long sublunule, etc...). It differs mainly from the other species of the subgenus *Laevifulvia* by the size, the homogeneity of the ribbing and IMR in the AT and MT, by the presence of a smooth PT2. Because of this latter character it approaches the genus *Laevicardium* (convergence).

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REFERENCES:

- AUDOUIN, V., 1827 - Explication sommaire des planches de Savigny. Panckoucke, Paris.
- BARASH, A. & Z. DANIN, 1992 - Annotated list of Mediterranean Mollusks of Israel and Sinai. *Fauna Palaestina*. Mollusca 1. The Israel Acad. of Sciences and Humanities. Jerusalem.
- BRUGUIERE, J.C., 1789 - Encyclopédie Méthodique, Histoire Naturelle des Vers, 1. Panckoucke, Paris.
- CHEMNITZ, J. H., 1782 - Neues Systematisches Conchylien Cabinet, 6. Raspe, Nürnberg.
- DELESSERT, B., 1841 - Recueil des coquilles décrites par Lamarck et non encore figurées. Fortin, Masson et Cie, Paris.
- DESHAYES, G. P., 1863 - Catalogue des Mollusques de l'île de la Réunion (Bourbon). Dentu, Paris.
- DILLWIN, L. W., 1817 - Descriptive Catalogue of Recent Shells, I.J. & A. Arch, London.
- DODGE, H., 1952 - A Historical Review of the Molluscs of Linnaeus, Part1, The Class Loricata and Pelecypoda. *Bull. Amer. Mus. Nat. Hist.*, 100, art.1.
- DONOVAN, E., 1826 - Naturalist's Repository, 4.
- DRIVAS, J. & M. JAY, 1988 - Shells from Réunion, 18 Fam. Cardiidae. *La Conchiglia*, 20 (232,233): 13-17.
- DUNKER, G., 1860 - Neue Japanische Mollusken. *Malacozool. Blätt.*, 6: 221-240.
- DUNKER, G., 1861 - Mollusca Japonica Descripta et Tabulis Tribus Iconum. Stuttgartiae.
- FISCHER-PIETTE, E., 1977 - Révision des Cardiidae (Mollusques Lamellibranches). *Mém. Mus. Hist. Nat. Paris*, N.S.A, 101.
- GRAY, J. E., 1847 - A list of the Genera of Recent Mollusca, their synonyma and types. *Proc. Zool. Soc. London*, Part 15: 129-219.
- GRAY, J. E., 1853 - A revision of the genera of some of the families of Conchyfera or Bivalve shells. *Ann. Mag. Nat. Hist.*, (2), 11: 33-34.
- GRONOVIVS, L. T., 1781 - Zoophilacium Gronovianum. Th. Haak & al. Leiden.
- HEALY, J. & K. LAMPRELL, 1992 - New species of Veneridae, Cardiidae,... from Australia (Veneroida, Bivalvia, Mollusca). *J. Malac. Soc. Australia*, 13:75-97.
- HIDALGO, G., 1903 - Estudios preliminares sobre las Faunas Malacologicas de las Islas Filipinas. *Mem. Acad. Cienc. Madrid*, 21: 207-306.
- IREDALE, T., 1929 - Strange molluscs in Sydney harbour. *Australian Zool.* 5, part 4.
- JANSSEN, R., 1993 - Die Typen der von Dunker 1860/1861 beschriebenen japanischen Meeresmollusken. *Arch. für Molluskenk.* 112: 403-435.
- KAFANOV, A. I. & S. V. POPOV, 1977 - On the system of the Cenozoic Cardioidea (Bivalvia). *Paleontological Journal*, 11 (3): 307-314.
- KEEN, A. M., 1936 - Revision of Cardiids Pelecypods. *Proc. Geol. Soc America* for 1935, Preliminary abstracts: 367.
- KEEN, A. M., 1951 - Outline of a proposed classification of the Pelecypod family Cardiidae. *Conchological Club of Southern California, Minutes* 111: 6-8.

- KIRA, T., 1962 - Shells of the Western Pacific in Colour. Hoikusha, Osaka.
- KRAUSS, F., 1848 - Die Südafrikanischen Mollusken. von Ebner & Seuberg. Stuttgart.
- LAMARCK, J. B., 1809 - Philosophie zoologique...Dentu, Paris.
- LAMARCK, J. B., 1819 - Histoire Naturelle des Animaux sans Vertèbres, 6(1). Paris.
- LAMPRELL, K & T. WHITEHEAD, 1992. Bivalves of Australia 1. Crawford House Press, Bathurst.
- LUDBROOK, N. H., 1984 - Quaternary Molluscs of South Australia. Dept. of mines and Energy, South Australia, Handbook No 9.
- LYNGE, H., 1909 - The Danish Expedition to Siam 1899-1900. IV, Marine Lamellibranchiata. *Mem. Acad. Roy. Denmark*, Ser. 7, 5, (3).
- NIEBUHR, C., 1775 - Descriptiones animalium...quae observavit Petrus Forsskal. Mølleri, Copenhagen.
- NOMURA, S. & H. NIINO, 1940 - Mollusca dredged from off the coast of Hukui Prefecture in the Japan Sea. *Rec. Oceanogr. Works Japan*, 12, 1: 23-81.
- PILSBRY, H. A., 1904 - New Japanese Marine Mollusca. Pelecypoda. *Proc. Acad. Nat. Sci. Philadelphia*, 56: 550-561.
- PRASHAD, B., 1932 - The Lamellibranchia of the Siboga expedition. Systematic, Part 2. Pelecypoda. Brill, Leiden.
- REEVE, L., 1844 - Conchologia Iconica, *Cardium*, Sp. 44-64 (Sp 47 excluded).
- REEVE, L., 1845 - Conchologia Iconica, *Cardium*, Sp.47 & Sp. 65-82.
- REID, R. G. B. & P. K. S. SHIN, 1983 - Notes on the biology of the cockle *Fulvia hungerfordi* (Sowerby). *Proc. 2nd Intern. Workshop on the Malacofauna of Hong-Kong and Southern China*, Part 2, 1: 274-282.
- SAVIGNY, J. C., 1805-1812 - Planches de l'Expédition d'Egypte. Histoire Naturelle. Mollusques. Panckoucke, Paris.
- SCHNEIDER, J. A., 1992 - Preliminary cladistic analysis of the bivalve family Cardiidae. *Amer. Malac. Bull.*, 9 (2):145-151.
- SCHRÖTER, J. S., 1788 - Vollständiges Alphabetisches Namen Register von... conchylien Cabinets. Raspe. Nürnberg.
- SOWERBY, G. B., 1834 - The Conchological Illustrations, 48th-51st Parts.
- SOWERBY, G. B., 1840 - An extensive series of new species of the Genus *Cardium* exhibited by Mr Cuming. *Proc. Zool. Soc. London* (8): 105-115.
- SOWERBY, G. B., 1901 - Descriptions of five new Species of Marine Shells. *J. Malac.*, 8: 100-103.
- SPENGLER, K., 1799 - Over den toskallede Slaegt *Cardium* Linnei. *Skrift. Naturhist. Selsk. København* 5(1).
- SWAINSON, W., 1840 - A Treatise on Malacology, or Shells and Shell- Fish. Longman & al, London.
- TURTON, W. H., 1932 - The marine shells of Port Alfred, S. Africa. Oxford University Press, London.
- VOSKUIL, R. P. A. & W. J. H. ONVERWAGT, 1992 - Studies on Cardiidae. 6. *Gloria Maris* 31(3): 33-44.
- WILSON, B. R. & S. E. STEVENSON, 1977 - Cardiidae of Western Australia. *Western Australian Museum Spec. Publ.* 9.
- YARON, I., T. SCHIOTTE & G. WIUM-ANDERSEN, 1986 - A review of molluscan taxa described by P. Forsskal and C. Niebuhr..., *Steenstrupia* 12 (10):157-203.

PLATE 1 (opposite page):

- Fig.1 - *Fulvia undatopicta*, NC SE lagoon sta.703. MNHN. Real L=9.4mm.
- Fig.2 - *Fulvia undatopicta*, lunular heart, NC NW lagoon sta.992. MNHN. Scale: x14.
- Fig.3 - *Fulvia scalata*, lunular heart, NC N lagoon sta.1063. MNHN. Scale: x14.
- Fig.4 - *Fulvia scalata*, N Qld 15°45'-145°35', AMS C44644. Real L=3.0mm.
- Fig.5 - *Fulvia mutica*, periostracal insertions in the PT. Japan. MNHN. Scale: x45.
- Fig.6 - *Fulvia fragilis*, periostracal insertions in the PT. Aden. MNHN. Scale: x55.
- Fig.7 - *Fulvia papyracea*, periostracal insertions in the MT. Subic Bay Philippines. MNHN. Scale: x150.
- Fig.8 - *Fulvia dulcis*, posterior part. NC SE lagoon sta.688. MNHN. Scale: x13.
- Fig.9a-b - Selected lectotype of *Cardium apertum* Brug. and *C. hians* Spengler. Real L=48.1mm.
- Fig.10a-b - Holotype of *Fulvia voskuili*. Real L=33.8mm.
- Fig.11a-b - Holotype of *Cardium papyraceum*. Real L=37.4mm.
- Fig.12a-b - Syntype of *Cardium annae* figured by Pilsbry. Real L=27.2mm.

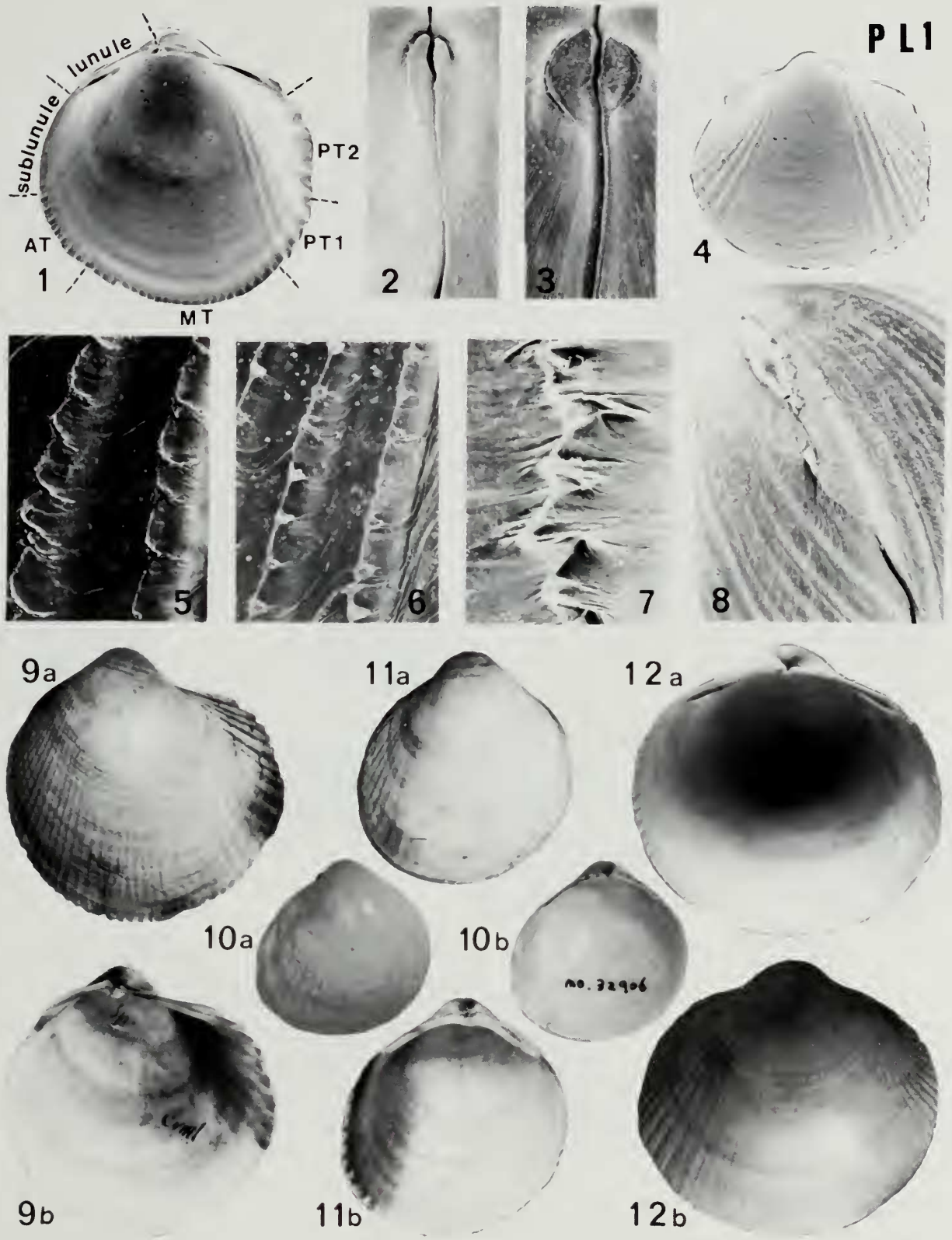
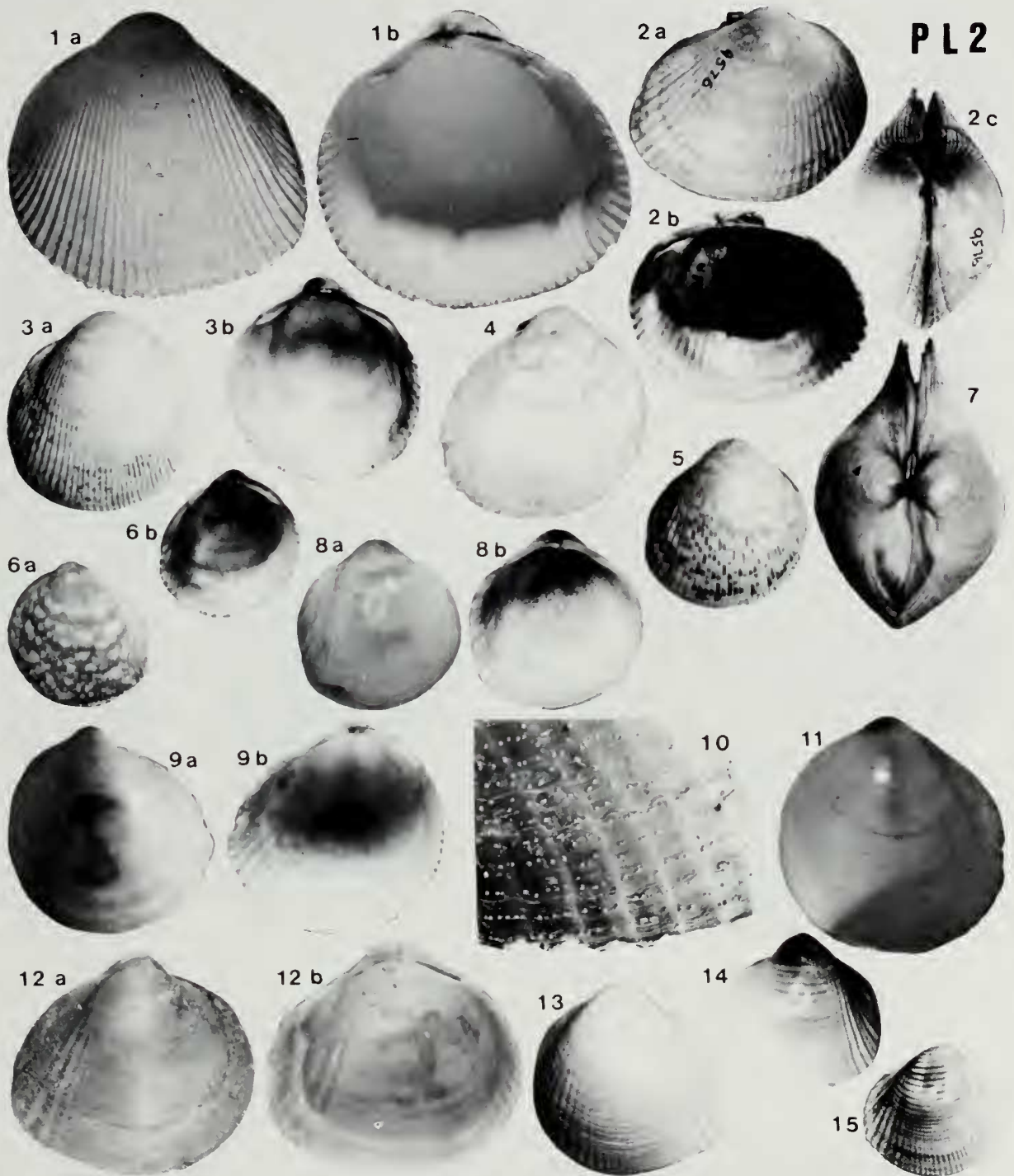


PLATE 2 (opposite page):

- Fig.1a-b - Selected lectotype of *Cardium tenuicostatum*. Real L=54.0mm.
Fig.2a-b - *Fulvia natalensis*, Port Elizabeth SA, NM 5776. Real L=39.0mm.
Fig.2c - *Fulvia natalensis*, Port Elizabeth SA, NM 5776. Real L=37.4mm.
Fig.3a-b - *Fulvia australis*, NC S lagoon sta.557, depth 44m. MNHN. Real L=31.9mm.
Fig.4 - *Fulvia australis*, N Qld Fantome Is, QM mo 45527. Real L=34.6mm.
Fig.5 - *Fulvia australis*, NC Nouméa, MNHN. Real L=27.1mm.
Fig.6a-b - *Fulvia australis*, N Qld Shelburne Bay, QM mo 45517. Real L=24.8 mm.
Fig.7 - Selected lectotype of *Cardium apertum*. (See pl.1, fig.9a-b).
Fig.8a-b - Selected lectotype of *Cardium dulce*. Real L=11.5mm.
Fig.9a-b - *Cardium hungerfordi undatopictum*, syntype figured by Pilsbry. Real L=17.5mm.
Fig.10 - *Fulvia undatopicta*, detail of the AT, NC SE lagoon sta. 703, MNHN. Scale: x22.
Fig.11 - *Cardium hungerfordi stigmaticum*, syntype figured by Pilsbry. Real L=11.03 mm.
Fig.12a-b - Two syntypes of *Cardium hungerfordi*. Real L respectively 8.0 and 8.4mm.
Fig.13 - *Fulvia hungerfordi*, Philippines N of Panay Is., sta. DR 140, MNHN. Real L=13.6mm.
Fig.14 - *Fulvia hungerfordi*, Indonesia N Sumba Is. ZMA. Real L=12.4mm.
Fig.15 - *Fulvia hungerfordi*, NC Gatope Beach, MNHN. Real L=9.0mm.



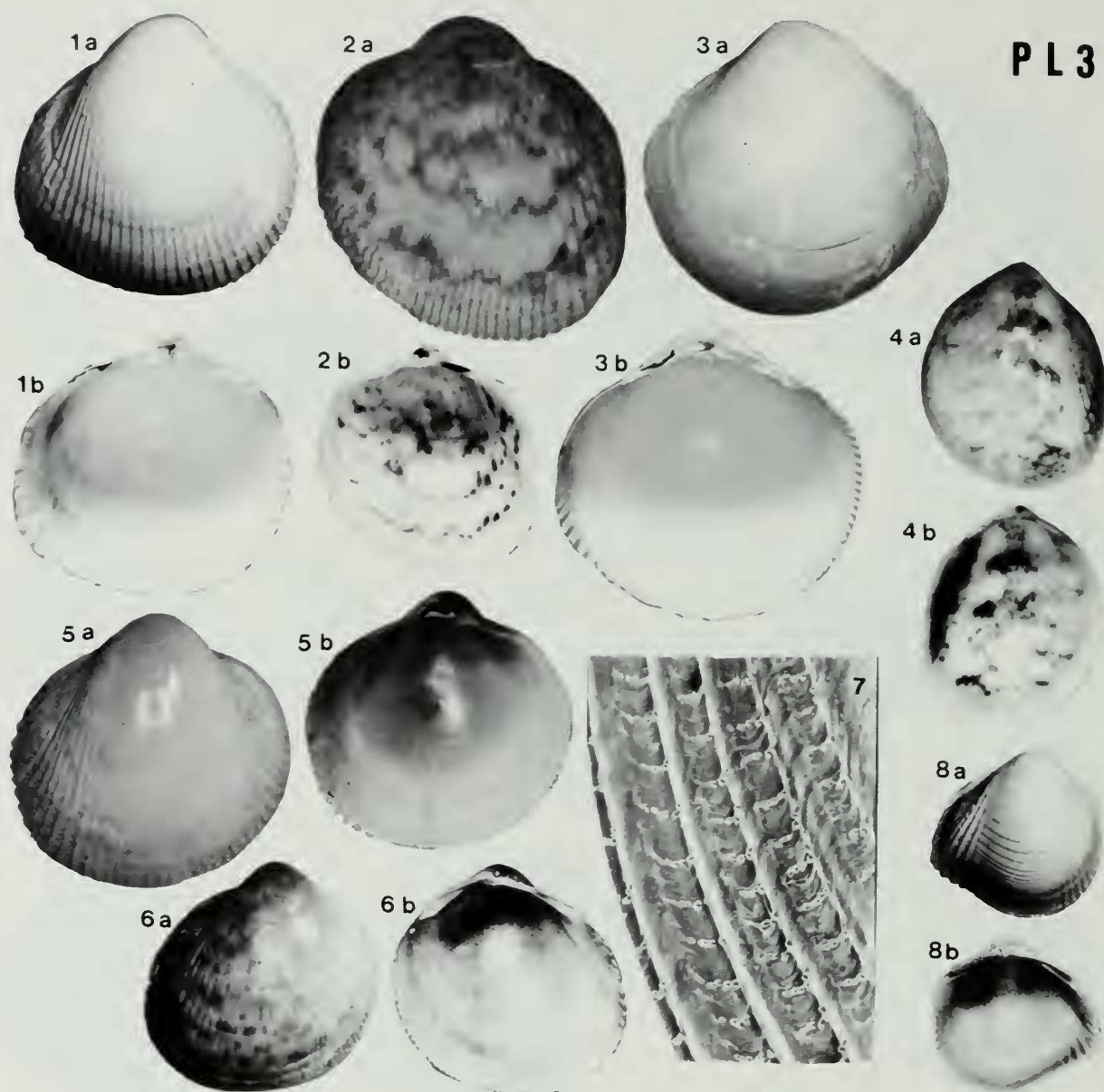


PLATE 3:

Fig.1a-b - *Fulvia fragilis*, Zanzibar, MNHN. Real L=45.3.

Fig.2a-b - Holotype of *Fulvia fragiformis*. Real L=11.0mm.

Fig.3a-b - Holotype of *Fulvia ballieni*. Real L=49.3mm.

Fig.4a-b - Holotype of *Fulvia lineonotata*. Real L=10.2mm.

Fig.5a-b - Holotype of *Fulvia scalata*. Real L=19.3mm.

Fig.6a-b - Holotype of *Fulvia boholensis*. Real L=35.2mm.

Fig.7 - *Fulvia scalata*, detail of the AT, NC NE lagoon sta. 846, MNHN. Scale: x25.

Fig.8a-b - Holotype of *Fulvia prashadi*. Real L=10.2mm.